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MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

VOLUME XVIII

CONTAINING PAPERS SUBMITTED AT THE ANNUAL MEETING IN 1932

(The papers in Botany, Forestry, and Zoölogy of the 1932 meeting appear in Volume XVII.)

PAPERS

OF THE

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

EUGENE S. McCARTNEY
UNIVERSITY OF MICHIGAN

PETER OKKELBERG
UNIVERSITY OF MICHIGAN

VOLUME XVIII

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
— SENECA, *Naturales Quaestiones*

Ann Arbor
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AN ACKNOWLEDGMENT

ELEVEN years ago the manuscript for Volume I of this publication was submitted to the Graduate School of the University of Michigan for preparation for the press. At that time six sciences were represented. The task of editing would have been an arduous one for a scientist of wide attainments, but for me, a classicist by training, it was a real ordeal. As difficulties were surmounted new problems were presented by the addition of a second annual volume and by the organization of new sections of the Academy. In spite of obstacles improvements were made until eight volumes had appeared.

When Volumes IX and X went to press Mrs. Alice Foster began to read proof for the Plimpton Press. Before I had finished work on the first installment of galley proofs, which contained a long paper of my own, I knew that a person of rare gifts was enthusiastically coöperating with me. I had never seen proof reading raised to so high a plane of scholarship. Since that time her interest and her ardor have never waned. Her devotion to this work is not excelled by my own. Mrs. Foster has never been a reader save in name; she has been a fellow-editor, although the responsibility and the decisions, both wise and unwise, have naturally rested with the official editor.

In volumes of this kind there are always blemishes, some of which represent reluctant concessions of the editor, but his most efficient work amid the intricacies of modern manuscripts is not even suspected unless the reader happens to be also an editor. Technical papers in fields of learning so diverse as those comprised in the Academy volumes create a maze of problems, many of which are difficult of solution. In all these subjects Mrs. Foster has been alert in detecting any lapse from the best form and equally resourceful in suggesting improvements. It is a real pleasure to make an acknowledgment of her unfailing aid.

I wish also to thank the entire staff of the Plimpton Press. For eleven years I have received whole-hearted assistance from its members. Their help and suggestions have always been welcome.

E. S. McC.

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OLD INDIAN TRAILS IN THE SAGINAW DISTRICT, MICHIGAN

FRED DUSTIN

INTRODUCTION

MANY years ago the author became interested in the ancient Indian remains in the vicinity of Saginaw. As interest increased the subject developed, and attempts were made to record as well as to collect the evidences of prehistoric culture.

It seems certain that the present City of Saginaw was a center of Indian population, and that Saginaw County was in the heart of a district which was almost ideal for its primitive inhabitants. Converging streams, great supplies of game, fish, wild rice, fruits and nuts, and rich bottom lands where corn could be easily grown, made it in fact "a happy hunting ground." As a consequence of these natural advantages canoe routes and trails centered at *Kah-bay-shay-way-ning*, "The Gathering Place" of the Chippewa, now Saginaw.

A glance at the map of Michigan shows that Saginaw is not far from the geographical center of the Lower Peninsula, and that, with the twenty miles of sluggish estuary now called the Saginaw River, Saginaw Bay, projecting fifty miles southwestward, furnished an unobstructed waterway to any point on the Great Lakes.

As the canoe routes followed the streams, so did the trails follow the lines of least resistance, avoiding a swamp here, fording a stream there, and traversing a sandy ridge elsewhere. They, too, converged at the same place where later the railroads, highways, and steamboat lines came together and introduced a new phase of culture where primitive man had for unknown centuries held sway.

The pioneers are gone, but old records, maps, diaries, and some physical evidence still exist, from which sources, along with

information given by persons now deceased, it has been possible to piece together an account of these old paths.

Some years ago, at the request of Dr. W. B. Hinsdale of the University of Michigan, the author prepared a map of Saginaw

Map 1. Indian Trails in the Saginaw District, Michigan

County showing these ancient highways. This was used later by Mr. Edward J. Stevens in his fine cartographic work for Dr. Hinsdale's *Archaeological Atlas of Michigan*.[1] The part of Map 9 which shows Saginaw County is here reproduced (Map 1) in sim-

[1] University of Michigan Press, Ann Arbor, 1931.

plified form. Of the archaeological features only the main trails are retained. The author is indebted to Mr. Stevens for the preparation of this map.

On many a summer day the author has followed some of these trails along a winding road by a river, or on lands where the old forest growth still stood, and has noted an almost imperceptible path that long ago was trod by the foot of the red man.

Perhaps sentiment has no place in a scientific paper, but the scientist who has no sentiment in his heart has missed one of the greatest inspirations to reflection and investigation, for it is only through the imagination that one can reconstruct that part of the past which has left no material evidence of its existence.

Some of us cannot dwell on these things without a feeling for those who have gone before, and we realize that our best thoughts have come to us from our association with the Great Mother in field and forest, by mountain and stream.

THE SAGINAW BAY AND LAKE MICHIGAN TRAIL

On a very old map [2] showing the present State of Michigan a trail extends from Saginaw Bay to Lake Michigan. So far as known, it is the first map indicating any trail in the Lower Peninsula. It seems evident that this was considered an important highway.

Leaving the present City of Saginaw where the ruins of the Plate Glass Works stand, it followed a general westward course to the Tittabawassee River, which it struck a quarter of a mile west of the Michigan Central Railroad. Here the stream was forded and its bank followed to the Frazer Mound and Village, a hundred rods northwest, thence southwest to Swan Creek, which was usually crossed in Section 34, Thomas Township, near the Pere Marquette Railroad bridge, or sometimes a mile and a half south, near the Michigan Central Railroad bridge.

From the first crossing the trail followed the sandy moraine to Sand Ridge Station on the Pere Marquette Railroad; then bending southward along the low ridge for some distance, it

[2] Unfortunately, the title of the volume in which the author saw this map has slipped his memory, but he is sure of his data.

again turned west for three quarters of a mile to a point a mile north of Garfield Station on the Michigan Central Railroad, and thence south to the forks of the Bad River, where St. Charles is now located.

From this place the trail proceeded southwest on the north bank of the South Branch [3] of the Bad River and crossed the county line between Saginaw and Gratiot counties about two miles north of the Shiawassee County line, continuing to and down the Maple River to the Grand, which was followed to Lake Michigan. The archaeologist who passes over this old trail from St. Charles up the South Branch will note, at the point where he crosses the road to Brant, the remains of the Saginaw and Grand River Canal, three quarters of a mile of which was made by digging out the river bed and building some retaining walls of piles and earth.

The first road up the South Branch followed this trail for eight miles or more, but parts of it have fallen into disuse. This situation also applies to some other sections, such as the part from the Plate Glass Works to the Tittabawassee River, where the old road has been abandoned and straight roads have been made.

THE DETROIT AND SAGINAW TRAIL

In 1831 the eminent French traveler, essayist, and philosopher, Alexis de Tocqueville, came to America, and in his quest for information visited many places. A chapter from his writings, "A Fortnight in the Wilderness," [4] describes his trip on horseback from Detroit to Saginaw, then a settlement of barely thirty whites. At that time the section of road from Flint to Saginaw, now a part of the Dixie Highway, was not in use, although it had been surveyed as a military road and several years before had been bushed out by soldiers from the Flint River to the Cass. It is sometimes erroneously stated that this road followed the Indian Trail from Flint, but from this place it was surveyed

[3] The official names for the branches of the Bad are North Branch and South Branch. To the Chippewa they were, respectively, *Mis-a-bos Se-be* ("White Rabbit River") and *Maw-tchi Se-be* ("Bad River").

[4] *Memoir, Letters and Remains of Alexis de Tocqueville*, in two volumes (Boston, 1862), 1: 139–206.

in straight lines to the Cass, having no relation to the trail which was about five miles west. From the crossing of the Cass to Bridgeport it approximately paralleled the Cass River Trail, although the survey still followed straight lines, leaving the trail proper between it and the river.

At Bridgeport, not far east of the present junction of the Washington-Williamson Road with the Dixie, it entered the Detroit and Saginaw Trail, following it over the Washington Road. Fortunately, the surveyors did not attempt to run straight lines on this stretch of the road, but followed the windings of the trail, so that today the traveler who leaves the Dixie at Bridgeport and takes this route to Saginaw is passing over an ancient highway, used perhaps centuries before the white man saw this continent.

The main trail ran directly to where the Tittabawassee and Shiawassee rivers unite to form the Saginaw, but a branch which the military road followed bore to the right and ended at the present Mackinaw Street bridge.

De Tocqueville's narrative is of great interest, but, as might be expected, his descriptions of localities are confused, and it is only by patient study and a knowledge of the topography of the region that it is possible to harmonize what seem to be conflicting statements.

After crossing the Flint River at Flint the trail did not again touch that stream until the line between Saginaw and Genesee counties was reached; from there it followed the river bluffs to the township cemetery in Taymouth, thence in a general northerly course to the Cass River, which was forded half a mile above the present highway bridge at Bridgeport, meeting the Cass River Trail, as previously mentioned.

From the Taymouth cemetery a branch passed down the Flint through what is now Foster's Village to a point a mile west of the town line between Bridgeport and Spaulding townships, touching the east and west town line between Albee and Spaulding townships. It then turned north, crossing the Cass half a mile west of the East Street bridge, and joined the main trail at the confluence of the Tittabawassee and Shiawassee.

We know that De Tocqueville followed the main trail through Bridgeport. Another man, a soldier and statesman, General Lewis Cass, had preceded him twelve years, having ridden from Detroit to Saginaw with his staff to make the treaty with the Indians in 1819. We find no record of his journey, and we do not know whether he came over the main trail by way of Bridgeport or followed the west branch down the Flint through Foster's Village. The former route seems probable, since it was the better trail and the one more frequently traveled. His soldiers and supplies came by water, but he preferred the wilderness path. From Detroit to Flint the Dixie Highway follows the trail, and its long curves are permanent monuments to the red men who "laid it out" without chain or compass, selecting a path upon which the white man could not improve.

THE TRAIL TO SAGINAW BAY FROM DETROIT

On one of the old maps showing Indian Reservations in Michigan [5] we find a trail marked "Old Indian Trail to Saginaw Bay," which ran due northwest from Detroit to the forks of the Shiawassee River at Byron and passed on to the crossing of that stream at Owosso, where it turned north. Approximately following the river to Chesaning, which it again crossed, it proceeded to St. Charles, where it joined the Saginaw Bay and Lake Michigan Trail to Saginaw.

From the Glass Works in Saginaw it followed the sand ridge to the present junction of Maple Street and Michigan Avenue, continuing on the line of the latter to near the north city limits, where the Pere Marquette Railroad crosses it, from which point it bore northwest on the Hermansau Road to the Bay County line. It then turned northeast and crossed the Squaconning Creek, where the bridge on Highway M–47 is located, approaching the Saginaw River at Salzburg (Bay City), and continued on to the bay.

[5] *Eighteenth Annual Report, Bureau of American Ethnology* (Washington, 1899), Part 2, Plate 31.

THE MACKINAW TRAIL

The term "Mackinaw Trail" is slightly confusing. From Bay City a trail north, following a sandy ridge, is called the Mackinaw Trail, but properly speaking, should be designated as the Shore Trail, for from Pinconning it turned northeast, following an ancient beach line at least as far as the Rifle River, and continued along the Lake Huron Shore far up toward, and perhaps to, Mackinaw. It is known that a trail ran up the Rifle River to its headwaters; in all probability it joined the true Mackinaw Trail northeast of Houghton Lake.

The Shore Trail in early lumbering days, and the Rifle River Trail later, became the "Bay City Tote Road," used by loggers for hauling their camp supplies and equipage.

The true Mackinaw Trail left Saginaw at a point near the Court House and struck the Tittabawassee River above the State Street bridge. From there it followed the stream toward its sources, touching Houghton Lake, then going on to Mackinaw. The east river road, M–35, passes over this trail to Midland, and a river road farther on marks the line to Sanford.

It seems probable that this trail was not much used above Sanford, where the Salt River enters and the Tittabawassee makes a great sweep to the north, but to this point the Indian remains are relatively numerous. At Midland, where the Pine enters the Chippewa, which in turn empties into the Tittabawassee, two principal trails left the Mackinaw, one up the Chippewa, the other following the Pine.

In Saginaw County the most numerous prehistoric remains are on the opposite or southwest bank of the Tittabawassee, where another trail paralleled that stream. Village after village marked its course to Midland County and perhaps farther. The reason for this lay in the fact that the southwest bank of the river was bordered by a series of sandy moraines on which a fine growth of pine was the principal cover, making the clean open woods which the Indian loved. It was also higher on the southwest side, and no streams entered from the east until the headwaters were reached.

The Mackinaw Trail was, therefore, somewhat like the transcontinental railroads in their early days, a means of communication between important points far apart, with many uninhabited spaces between.

In 1836 Lieutenant Poole of the Third Artillery of the United States Army surveyed "A Road Route from Saginaw to Mackinac M.T."[6] The platted sketch, with its numerous and precise notes of the route, indicates that it followed the general course of the Tittabawassee, leaving Saginaw by way of Mackinaw Street and continuing along the present Mackinaw Road outside the city. It seems to have kept at a distance of from three to four miles from the river, which it first touched forty miles from Saginaw. From this point it followed the trail along the stream for ten miles; leaving the river it continued north ten miles farther, where it crossed the headwaters, and four miles beyond skirted for a mile the west branch of the Tittabawassee and passed on to the northeast, crossing the upper course of the Au Sable and finally terminating at Mackinaw.

The logical road to Mackinaw was by way of Bay City over the Shore Trail to Pinconning and on north, but in Lieutenant Poole's survey we see the influence of the Indian trail up the Tittabawassee, for it followed the higher lands, which caused the authorities to believe it to be the most feasible route.

THE CASS RIVER TRAIL

A part of the Cass River Trail has been described in previous pages as lying along the course of the military road from Bridgeport to the crossing of the Dixie Highway over the Cass. It continued up the river as far as Cass City and probably beyond. At Frankenmuth a trail from the south joined it, and at Tuscola Village it was crossed by an important trail which branched off from the Detroit and Saginaw Trail at Flint, running north through Pine Run, Arbela, and Elva across the Cass at Tuscola, where it turned northwest and reached Bay City. At Vassar a trail which made many wide curves to avoid marsh lands led to Quanicassee, and just below Caro another crooked path left the main trail,

[6] Senate Document 234, Twenty-fifth Congress, Second Session (1837–38).

taking a west and north course, and joined the Quanicassee Trail a few miles south of the point where the Quanicassee Creek emptied into Saginaw Bay.

At Caro another trail from the south, which passed Cat Lake in Dayton Township, crossed the Cass and continued north through Unionville to a small bay into which Wiscoggin River empties.

The Cass River Trail was a quite important highway, and ancient remains such as village sites, mounds, and burial places are numerous from the Town Line Road in Saginaw County to Vassar and probably beyond.

From a point two miles below Cass City to a point seven miles above, the river bed is an outcrop of rock, some formations of which furnished the Indians with chert nodules for arrow points and also two varieties of stone suitable for pipes.

On the south bank of the Cass from Bridgeport to Vassar another trail existed, and the remains of prehistoric culture seem to be more numerous than along the main trail. Two miles east of the Dixie Highway a short section of this primitive path may still be seen where it crosses a steep knob or knoll of sand, which is dotted with Indian storage or corn pits. Since the land has never been cleared and since a second growth of pine has sprung up, these interesting remains are undisturbed.

THE SWAN CREEK TRAILS

Swan Creek rises in Midland and Saginaw counties. It parallels the Tittabawassee River for about twenty miles, flowing into the Shiawassee six or seven miles above its junction with the former. Between the Tittabawassee and Swan Creek there are probably more ancient village sites than in any similar area in Saginaw County. Two trails followed the general course of Swan Creek, the principal one on the east bank beginning at its lowest inhabitable point a mile south of Swan Creek Station on the Michigan Central Railroad and running up into Midland County.

This was one of the best game localities in Saginaw County, and no low or marsh land was encountered until the mouth

of the creek was approached. These circumstances made it a populous district and hence of especial interest to the archaeologist.

THE RIDGE ROAD TRAIL

The geology of the Saginaw region is of considerable interest. In the southern townships of Saginaw County ancient lake beaches are noted that are elevated more than a hundred feet above the present lake levels. One beach, the Arkona, is especially interesting. If we start from the village of Oakley, following the Ridge Road, we soon find ourselves on a low gravel ridge, and as we proceed westward note a peculiar difference in topography, soil, and vegetation that distinguishes the lands south of the road from those north of it.

Northward the surface is low and fairly even, the soil alluvial and clayey, and in places strewn with boulders, the typical bed of an ancient lake.

To the south of the road the land is higher, with broken contours, dunelike sand knolls, and sandy soil.

We are traveling on the old gravel beach, a natural road which long before our time was a much-used Indian highway. The author was informed by an early settler that years ago, when he attempted to plow a short piece of this trail either in road work or for cultivation, it was almost impossible to break up the compressed gravel, for the tread of feet for unknown generations had made it so compact that it was like a soft conglomerate rock.

This trail really began at the Detroit and Saginaw Trail, just south of the Saginaw County line, intersecting the trail to Saginaw Bay at Chesaning and passing on up the Shiawassee to Oakley on the west bank of the river; from that point it continued along the ancient beach to Chapin, thence southwest, still following the beach line into Clinton County, where it made a junction with the Saginaw Bay and Lake Michigan Trail.

NORTH BRANCH (BAD RIVER) TRAIL

From the forks of the Bad River at St. Charles a trail followed the North Branch west into Gratiot County, most of the way along its south bank. East of Ithaca it turned southwest and

joined the Saginaw Bay and Lake Michigan Trail. It is possible that a branch extended westward to the Pine River, for the linear-surveyors' notes indicate trail crossings at several section lines in that direction.

Near the mouth of Beaver Creek a trail left the Saginaw Bay and Lake Michigan Trail and followed the Beaver to its headwaters in Gratiot County and on to the Pine River, which it struck at or near St. Louis.

KISHKAWBAWEE TRAIL

The Kishkawbawee, which was a cross-country or connecting trail, began in the north edge of the Flint River Reserve at Kishkawbawee on the Flint, and ran almost due west across the Shiawassee to the Trail to Saginaw Bay. From Misteguay Creek a branch extended to Chesaning. A trail began some miles up the Misteguay, and followed that stream to its mouth. It crossed the Kishkawbawee trail where the Chesaning branch left it, and passed over the Flint River in Section 33, Spaulding Township, continuing northwest to within a mile of the Cass, where it entered the west branch of the Detroit and Saginaw Trail.

SHORT AND CONNECTING TRAILS

The author has endeavored to give some account of the principal ancient highways, but there is much of interest in the short and connecting trails and brief mention will be made of a few of them.

Beginning in James Township near the confluence of the Tittabawassee and Shiawassee rivers, a trail following the southwest bank of the Tittabawassee has been traced as far as the Midland County line and has been mentioned incidentally in the description of the Mackinaw Trail. Although it is classed as a minor trail, in its lower half it was much more traveled than the former. Twenty-one village sites along its course in Saginaw County, with many more at short distances on branch trails not far away, show us that relatively the aboriginal population was greater than the present white population.

At Mr. George Stroebel's farmhouse, eighty rods west of the

Merrill bridge in James Township, a branch trail left the one just described, and followed the sand ridges westward with short branches to the north and south. Half a mile west of Mr. Stroebel's there is a stumpy field, in which not many years ago part of this old trail was visible, a deeply worn path over which the pioneer children went to school. One of these, now dead, has related how, as a little girl, she was impressed by the beauty of the woods, and how the boughs and vines, forming a living arch over the path, left on her memory a picture never to be forgotten.

This trail continued west over sand ridges to Swan Creek, the western half becoming a winding road, now closed. In the days of his young manhood the author often followed its devious way and sometimes saw flint chips, the then unrecognized relics of a supplanted race.

Trails from Saginaw led to Menitegow of the Cass Treaty, now Zilwaukee (properly, Nemitequa),[7] and to Cheboyganing. A network of trails, most of them now untraceable, connected the great highways in the vicinity of Saginaw.

A small map in one of the previous volumes [8] of this publication gives some idea of the number of prehistoric village sites along these trails.

CONCLUSION

The old trails are gone and are only a dim memory to the oldest inhabitant. A few of their courses are marked by present-day roads; more have disappeared under the plow: like those who made them they have forever passed, but to thoughtful persons who dwell on those primeval days, their former existence brings a realization of the fact that where the Indians congregated, where their land and water routes converged, where they built their villages, there, too, the white man, following in their footsteps, built his highways and cities.

His first cornfield was on the ground where for generations the Indian had planted. He obtained his sugar from the trees

[7] Dustin, Fred, "Some Indian Place-Names around Saginaw," *Michigan, History Magazine*, 12 (autumn number, 1928): 729.

[8] Dustin, Fred, "Some Ancient Village Sites in Saginaw County, Michigan," *Mich. Acad. Sci., Arts and Letters*, 12 (1929): 89.

long before tapped by his predecessor, and even the pine boards of his boat were from the seedlings of other pines that had been fashioned into the Indian's dugout canoe.

Finally, the archaeologist who follows these old trails will find much that is worth while, such as village sites and attendant relics. There are some mounds and many burial places. Ancient cornfields can be pointed out and fords that mark the crossings of streams, but the culture of another race has left little to remind us of those who a little more than a century ago were the owners and rulers of our State.

Saginaw, Michigan

THE DAKOTA CEREMONY OF PRESENTING A PIPE TO MARSHAL FOCH AND CONFERRING A NAME UPON HIM

MELVIN R. GILMORE

MARSHAL FERDINAND FOCH, on his tour through America in 1921, planned to stop for a brief visit at Bismarck, the capital city of North Dakota. His special train over the Great Northern Railway arrived about 11 A.M. on Sunday, November 27. He had telegraphed that he would go to Mass immediately upon his arrival and thereafter would be at the disposal of the civic committee for whatever program they might have planned. Therefore, when the train arrived the Marshal was taken at once to the parochial school chapel of St. Mary's Church, where Mass was said for him and his party by a young priest who had been an officer in either the French or the Belgian army — I am not certain which.

After Mass the Marshal and his party were brought to the Bismarck city auditorium, which was packed to overflowing with townspeople. The entourage entered by the side door to the stage, where room had been reserved for them and for Governor Nestos, of North Dakota, and also for the commander and the first past-commander of the American Legion Post at Bismarck, the state commander of the American Legion, service men, and a delegation of men and women of the Dakota nation from the Standing Rock Reservation.

The band played the Marseillaise as a compliment to Marshal Foch. Governor Nestos made a speech of welcome, which was translated into French for him by General Parker, the official interpreter, detailed from the United States Army for this service during the tour. Then Marshal Foch made a good speech, which was excellently interpreted by General Parker.

In anticipation of the visit to Bismarck it had been planned that a delegation of men and women from the Standing Rock Reservation should have part in the ceremonies as representatives of their own nation, the Dakotas, in particular, and of all Indians in general. One of them was a member of the Fort Yates local War Mothers. Her son, a soldier in the American army, had been killed in action in France. The spokesman was Onspe-cikala-ša, commonly known by the English translation of his name, Red-tomahawk. This delegation of Indians, which had brought a ceremonial pipe to present to Marshal Foch, also wished to show him honor by conferring upon him a Dakota name.

The Indian delegation now took their turn in the program. First, Onspe-cikala-ša ceremonially presented the pipe, having been authorized to do so by popular sanction given in a council held previous to the event. Holding the pipe in his hand, he addressed the Marshal in the Dakota language. His words were translated into English by a young Dakota, who was the official Dakota-English interpreter of the Standing Rock Agency. The English was then rendered into French by General Parker. The English version of Onspe-cikala-ša's speech is as follows:

"My friend, the first time I ever heard of the great general, Marshal Foch, was at the time when we sent our young men to France to serve under him in fighting against our common enemy. At that time I did not think that I should ever see the great general; but today I have the honor and the pleasure of seeing him, and I am glad. In that war the young men of the French nation and the young men of the Dakota nation fought together in the same cause against our common enemy, and some of the young men of both nations died together in that struggle and were buried in the same ground."

Then he held up the pipe, which he had already filled, saying: "Among my people, the Dakotas, when we wish to make friends with others, it is our custom to offer the pipe and to smoke together; so, therefore, I desire to smoke with the Marshal and to give him this pipe as a token of friendship. Now this is the meaning of the pipe and its parts: The bowl is made from the red pipestone, a kind of stone which is found in only one place, south-

western Minnesota. This stone, which is of the color of blood and very fine grained and firm, is used to make pipe bowls because it signifies warm, firm, and lasting friendship. The stem of the pipe is made from the wood of the ash tree, a tough, durable wood of clear, smooth grain, to indicate that friendship pledged with the pipe shall be clear, durable, and unbroken. The hollow of the pipestem through which we draw the smoke is straight, denoting that the words proceeding from our lips shall be just and true, and that our paths shall be straight. The colors of these ribbons upon the pipestem also have their meanings. The white signifies that all former differences are cleared away, and that we shall be candid friends. The red ribbon is of the color of blood and betokens that we are all of one blood."

Then Onspe-cikala-ša held up the pipe toward the four quarters of the earth, to the North first, then the East, the South, and the West; then aloft toward the Sky, and then downward toward Mother Earth. This was a form of invocation to all the mysterious divine powers, asking for their blessing upon the meeting and upon all those present.

He then lighted the pipe, drew upon it, and offered the mouthpiece first to the Marshal, who also drew upon it (as he was instructed), and then to Major A. B. Welch, who, as Onspe-cikala-ša explained, was there to represent a deceased friend, a noted man of the Dakota nation, named Peži. He, too, drew upon it and then with both hands stroked the pipestem toward himself, in token of drawing to himself a blessing from the pipe. In offering the mouthpiece to the Marshal and to the representative of his old friend, Onspe-cikala-ša held the pipe in his own hands so that all three were thus brought into communion. Onspe-cikala-ša again drew smoke from the pipe. Then he made smoke offerings toward the four quarters, toward the Heaven, and lastly toward the Earth. After ceremonially emptying the ashes from the pipe, he presented it, and a pouch to contain it and tobacco, to Marshal Foch, as marks of esteem from the Dakota people and as mementoes of this occasion.

Onspe-cikala-ša was obliged to perform the ceremony in this short form because the time available did not permit him to give

it in full. For the same reason he also had to abbreviate the explanations of the ritualistic symbolism. Normally, all persons participating in the ceremony would have been seated upon the ground, upon the lap of Mother Earth. In giving a fuller explanation of the meanings of the colors and the accessories of the pipe he might have said that the white ribbon not only signifies that all differences are cleared away, but also symbolizes the white clouds sailing high in the blue sky of fair and propitious weather; that the blue ribbon represents the same clear sky of fair weather and buoyant hope; and that the red one signifies not only kinship in blood, but also the hope of life and provision for all its needs.

The green feathers upon the pipestem, which are from the neck of the wild mallard duck, are symbolical of water, the element in which ducks are at home and in which they find food and rest and safety, the element which is also imperatively necessary to all life. The green color signifies vegetation, too, which is the support of all animal life. When we see the feathers of the duck, we think of that bird's power and freedom in the air, on the land, and on the water. When we look at the green color of these feathers, we are reminded of the ever-returning promise of renewed life.

The material for smoking was a mixture of tobacco and the inner bark of a native shrub, a species of dogwood, *Cornus stolonifera*. Tobacco is native to tropical America in numerous species. Its use and cultivation were spread northward from one tribe to another throughout a large part of North America. One species (*Nicotiana quadrivalvis*), having been gradually acclimated by long selection under cultivation, is cultivated by the tribes of the upper Missouri River, who prefer it for all important or solemn ceremonies because it has for them more sacredness than imported tobacco. In Indian thought tobacco is invested with something of mystery and sanctity, and is used ceremonially as incense. The pipe is, therefore, a form of censer and a hearth for a sacred fire, and, accordingly, is an object to be treated with becoming respect and veneration. In smoking, Indians do not seize the pipestem, nor do they allow the mouthpiece even to touch the

teeth. To take the mouthpiece between the teeth would be considered almost an act of sacrilege. It is gently touched by the lips, and the smoke is then drawn through the stem. Fire and the breath of life, as well as the tobacco plant, are mysteries and sacred things. In the act of smoking, these mysteries are united. The stone pipe bowl is a diminutive altar on which is lighted a sacrificial fire; the smoker is a devotee. The circular rim of the pipe bowl reminds him of the encompassing rim of the earth and the sky; of the limitless circle of the universe; of the cycles of days, seasons, and years, and of the eternal round of all time. As has been stated, the straight line of the pipestem through which he draws the smoke reminds him of the straight line of truth and right. The smoke recalls to him the spirit which animates and inspires the universe. Such meditations as these dwell in the mind of an Indian while he is smoking.

The pipe and the mixture of tobacco and dogwood bark are carried in a long pouch, which is ordinarily decorated with designs worked in colored glass beads bought from traders, or in dyed porcupine quills prepared by the women. Both the forms and the colors of these designs also have their symbolical meaning.

After Onspe-cikala-ša had presented the pipe and pouch to Marshal Foch he stated that it had been decided, in accordance with the custom of his people, to bestow upon him the honor of a Dakota name, and that he was the one authorized to confer it. Several names had been considered, but finally "Waki^{n}ya^{n}-watakpe" had been chosen. This name, which had once been borne by a famous hero of the Teton-Dakota, now long since dead, had deep mystic significance in Dakota thought, for in Dakota mythology Waki^{n}ya^{n} is the dread mystic Thunderbird, the war god, whose dwelling is in the fearful western mountains, whose glance is the lightning, and whose voice is the thunder; the administrator of retributive justice, the avenger of injustice, the punisher of sacrilege. The word *watakpe* in the Dakota language means "to attack." Without knowledge of the circumstances under which the name Waki^{n}ya^{n}-watakpe was first conceived long ago, the exact meaning intended by it is somewhat ambiguous. We can hardly tell whether it is intended to denote one who is

like the lightning in swiftness and destructive attack, or one who is so intrepid as even to attack the lightning. The Dakota hero who once had this name is known by the supposed English translation "Charging-thunder," which is also non-committal as to whether the thunder (lightning) is charging (attacking), or whether one is charging upon the thunder (lightning).

When we remember the historic message sent by Marshal Foch at the first battle of the Marne, "I am attacking," the name Waki"ya"-watakpe seems to be a strange coincidence, for it is entirely unlikely that any of the Dakotas who combined in choosing this name had ever heard of the Marne message.

In Indian thought a man's life is a progression. If he has strong purpose and determination and seeks help from the higher powers, his life will move along an upward path. In the course of a man's life he comes to a place and a time in which his gifts of peculiar power have made possible some special achievement. This achievement marks the man's attainment to a higher level in the onward movement of his life. It is as if he now entered upon another stage in his career, so it is proper and permissible for him to receive a new name to mark his attainment to a new plane in life. Successive stages of achievement in a man's life might be marked by successive changes of name.

A man's name is a mark of his character. A name has a meaning, and the meaning of a man's name has allusion to an attribute of his character as shown in some act or course of action in his life. This relation of name and character must be one which was recognized and well known to those who knew the man. The name must be publicly announced in ritualistic form, and this announcement must be made by a man authorized to perform rites of mediation between man and the supernatural powers. The proclamation of a man's new name is formally made by invoking all the powers in the universe and making the affirmation that he is henceforth to be called by the new name, which is thus ceremonially announced.

The ceremony of conferring a new name is rather complex and long when given in full form. On account of the shortness of time on this occasion the proclamation had to be abbreviated.

Therefore, after saying, as already stated, that he had been authorized to confer a Dakota name upon Marshal Foch, Onspecikala-ša simply made the smoke offerings, as already described, and proclaimed in the presence of all the powers of the four quarters of the universe, to the earth, the hills and valleys, and the plains, to the waters, all springs and brooks and rivers, to the trees and grass and all vegetation, to the birds and all flying creatures of the air, to the four-footed creatures and all that walk and run upon the earth, and to all men, that this man here before them should henceforth be known as "Waki^{n}ya^{n}-watakpe." And so the ceremony ended.

University of Michigan

THE VICTORY DANCE OF THE DAKOTA INDIANS AT FORT YATES ON THE STANDING ROCK RESERVATION IN NOVEMBER, 1918

MELVIN R. GILMORE

IN FORMER times, while the Dakotas were still a free and independent nation, war parties returning home from a successful expedition were honored in a triumphal celebration called the Victory Dance, at which the people gave vent to their exultation. During the World War this nation's quota for service in the American army was more than filled with volunteers, and these young men notably rendered a good account of themselves in France. When the armistice came, their people at home naturally felt joyful over the victorious cessation of combat and the honorable part played in it by their own young men. To give expression to their feeling they desired to revive the ancient celebration of the Victory Dance. When the news of the armistice reached them on November 11, an epidemic of influenza was raging on the reservation. The ceremony could not be held then, and so it was postponed.

The Victory Dance was celebrated by several different communities of the Teton-Dakotas on the Standing Rock Reservation soon after the signing of the armistice, but the account here given describes the celebration held on November 30, 1918, near Fort Yates, at the community-center hall on the Porcupine River four miles northwest of Fort Yates. It is written from information obtained from Dr. A. McG. Beede, of Fort Yates, an eye-witness of the ceremony, who, having lived many years among the Dakotas, is conversant with their customs and understands and speaks the Dakota language readily. He arrived upon the scene about 1:00 P.M. The Victory Dances after the armistice in 1918

were the first held by the Dakotas since the one which was celebrated the evening after the victory over the expeditionary force of General Custer at the Little Bighorn River.

The central object in the Dakota Victory Dance is a straight, sound, healthy, young cottonwood tree. This is one of the mystic species of trees of sacred symbolism in Dakota religious uses. In the Victory Dance it signifies a young warrior of the enemy, a figurative representation of the overpowering of the enemy's military strength.

A party went down to the Missouri River to select and prepare a young tree satisfactory for the ceremony. When it had been chosen, a young girl of good habits and of a gentle and humane disposition, being, therefore, in harmony with Wakantanka who had decided the issues of the war, was delegated as the first to strike the axe into the tree. The tree should not touch the earth on falling, nor at any time after it had been felled until it was erected in the hole prepared for it at the dancing place. A bed of grass or other vegetation that had been plucked had to be made upon which to lay the tree. Since it was sacred when felled, no one dared step over it, or by any carelessness in its treatment show disrespect to it. After the branches had been trimmed off, the old men went to the place where the dance was to be held. The ritual prescribed that the tree be carried by men, not drawn by beasts. It was placed upon sticks, the ends of which were grasped by bearers, who thus walked in pairs, like pallbearers carrying a bier. The top of the tree was turned toward the camp, which suggests the head-foremost position in which the body of a fallen enemy was carried. During the ceremony the old men engaged in meditation and in a low voice chanted prayers.

There is no fixed ritual for these meditations, but the tenor of them is that Wakantanka permits the nations of men to grow and flourish like a tree till each has accomplished its mission on earth and then causes them to grow old and decay and fall like an aged tree; or, as lightning sometimes strikes a tree and lays it low while still in its full strength, so does Wakantanka send disaster and hurl down the arrogant nation which has grown proud and haughty and disobedient, and thus give the victory to those who

have suffered from that nation's arrogance and injustice. Another *motif* is that those who are now taking part in this ceremony are thereby worshiping the Righteous Power which pervades the universe.

After the tree had been brought to the place where the dance was to be held, the bark was peeled off. Then an old man painted the bare bole with black bands each a hand-breadth wide, separated from one another by a distance equal to that from the elbow to the tip of the middle finger. Black earth mixed with fat formed the paint, and was worked together and applied simply with the hands. This is the kind of paint which warriors use upon themselves; when put on the tree it symbolizes that the power of conquest has encircled the enemy until his surrender is complete.

After the tree had been painted, the carcass of a wolf was stretched across the top and tied to it with rawhide bands. When these rites had been accomplished the tree was raised and let into the hole prepared for it, and the loose soil was replaced and firmly tamped about the base to make it stand securely. The tree was so placed that the body of the wolf was on the north side, in a horizontal position, that is, parallel to the earth, with the head toward the east. A tress of horsehair was attached to the left temple of the wolf. This use of horsehair is, of course, a modern innovation since the Spanish introduction of the horse and its adoption by Indians. It is said the Victory Dance is the only occasion on which the wolf is used as an emblem of the defeated foe. This ceremony does not demand such strict fasting as does the Sun Dance, yet none of those who participate in it should partake of food on the day of its celebration until evening twilight falls.

The dead wolf near the top of the tree signifies that the enemy people have erred, so that at least temporarily the holy life has departed from them, and therefore they are vanquished. The part of the tree extending some four or five feet above the dead wolf is a reminder that over and above all the providences of Earth and Sky connected with the ordinary affairs of men, of animals, and of the birds of the air, and above their strength, wisdom, and cunning in attack and in defence, there are always the Holy Deity and the Holy Destiny ruling forever.

In the ceremony being described there was an innovation due to the present dominance of the white race. It was the attachment to the tree of a flagstaff bearing an American flag. Some of the young Dakotas, believing it might be distasteful to the white people to see the American flag thus closely associated with old Dakota emblems, suggested raising the flag on a separate staff as high as, or higher than, the tree. But the old members of the tribe would not consent to the separation. They insisted that the American flag should be put with the old Indian emblems, but in a superior position, because the white people had come to occupy this land with the Indians, and the white people's government had become the successor to the old Indian government, owing to its greater efficiency in world affairs, as was shown by the success in the World War. They said that now the Indians and the white people had become united into one great nation; that the contributions of both the old Indian and the white cultures had been brought together into one store for the benefit of all. Examples were the corn and other Indian crops which had been united with the crops which the white men had before, thereby adding so much to the country's food supplies.

They said, therefore, that the American flag, now their own flag as well as that of the white people in this land, should be attached to the Indian sacred tree, and should wave above the other emblems because white men by their superior wisdom and power had enabled the united Indians and white people under that flag to win this war for the freedom of all peoples. They desired that the flag be placed at least a short distance below the top of the sacred tree. But the young men lashed the flag to the tree with rawhide thongs in such a way that when erected it waved entirely above the top of the sacred tree. When the older people saw this they were much distressed because this position of the flag appeared to imply the idea of superiority over the Holy Deity who rules in all the Earth and Waters and Sky forever. They felt that no victorious people should assume to exalt themselves above the fallen foe in the place of the Holy Deity who is over all. The flag should, therefore, have been attached above the dead wolf, but not above the top of the sacred tree itself.

At this ceremony no sacred fire was lighted and no peace pipe was brought into use, for by Indian custom such ceremonies must be deferred until the soldiers return. At the proper time after their return the Sun Dance would be held, and each soldier could pay his Sun Dance vows. Also on that occasion all those who had remained at home during the war would perform the vows of sacrifice they had made.

At noon the dancing began. The singers, gathered about the great drum, were in the center. Those who took part in the dancing were dressed in old-time costumes, and each carried a tomahawk or a hatchet. All men and women present were painted on the chin with the same black-earth mixture which had been used on the sacred tree. All who assisted or participated in the Victory Dance wore some Indian article of dress or some Indian emblem, even if only the black paint upon the chin. The officers who applied the paint did not touch the chins of the white persons present, unless they well knew that it would be acceptable. This painting of the chin indicated participation in the celebration of the Victory Dance, though the person so painted might not actually dance.

Like all Indian dances, the movement circled round the singers and drummers in the same direction as the apparent course of the sun. But in this ceremony the dancers formed not a single circle, as most Indian dances require, but were sometimes two or three or even five or six deep in concentric circles, depending upon the number of persons who might feel like taking part at any one time. Again, contrary to the custom in some other dances, the participants occasionally would reverse individually the direction of their steps, or would plunge outside the circle for a short distance and then back again, constantly brandishing the tomahawk or some other weapon. These irregular movements were intended to symbolize the clash and confusion of battle, as well as the idea that war is an abnormal condition in human society. In the Victory Dance it is customary for the dancers to circle more closely about the drum and the singers than in other dances. It is said this signifies that those who are engaged in warfare are in a state of especially close dependence upon the supernatural powers.

During the ceremony there were frequent pauses in the dancing, while speeches were being made by both Indians and white men who were taking part. Among the white men who thus participated were Dr. Beede, who, as a missionary of the Episcopal Church, has been resident among the Dakota people for more than twenty-five years, and Mr. Carignan, who has been for many years a well-liked and trusted merchant in the Indian trade. It is said that none of the speakers, white or Indian, gave expression to any desire for revenge upon the enemy. All the speeches made by Indians revealed a feeling of reverence and of recognition of Wakantanka as the source of victory, and of magnanimity toward the vanquished foe. As upon other occasions of dancing, during the intervals of pause and sometimes even during the dancing, individuals brought gifts and made offerings to the "United War Work Campaign" and to the Red Cross. The gifts to these causes, on the occasion of the Fort Yates Victory Dance, amounted to $263.40 in currency, and two horses and a colt. At a similar dance held at the same time at Cannonball, a neighboring community, the gifts totaled $216.00 in money, and six horses. At Victory Dances at other communities on this Reservation offerings for these causes were made in like generosity.

Mr. Carignan stated in his speech that Indians in Sioux County alone had purchased about $100,000 worth of Liberty Bonds and had given more than $2,000 to the Red Cross.

Besides the singing of old-time Victory Dance songs there were several original songs spontaneously composed for this occasion, one of which runs as follows:

Eheye, ehaye, ehe!	"Proclaim it!
Eheye, ehaye, ehe!	Proclaim it!
Eheye, ehaye, ehe!	Proclaim it!
Tuka^{n}šina yapi	The President commanded
Akicita maši	Me to be a soldier
E! Iašica ki^{a}	Well! The Germans
Wayaka obluspa	Were beaten
	And broken to pieces.
Na bokabye u^{n}ye!	"And we rush on!
Kuleyayeyelo!	Down-down-down they go!
Bokabkabye u^{n}pe!	Rush on! rush on! rush on!
Kuliyekuliye yayo!	Down they go! down they go!"

The author of this song said: "I am sixty-five years old. I was brought up wholly among Indians. I never went to school. I never took part in any Indian dance before. I have been a Christian [a Catholic] ever since childhood, and so have taken no part in Indian religious ceremonies. When the war began I could not believe what I heard about the cruelty of the enemy. But as time went on I had to believe it. And then I began to pray at dawn and at midday, at evening twilight and at midnight. I prayed to Wakantanka to influence the American people, whites and Indians together, to go into this war to put a stop to such wickedness and injustice. I prayed in the old time Indian way and I made Sun Dance vows in my prayers, for it seemed to me I should be willing to make some sacrifice for a cause so important to human beings. And when the Americans went into the war I had much faith and I prayed still more earnestly and made Sun Dance vows. So now since Wakantanka has given us the victory I have come to worship him by participating in this Victory Dance; and I feel no sin in doing so. I wish to give a colt now as my sacrifice, and I wish Šiptō [Dr. Beede] to give the colt a name and to put a low price upon her, so that it will be possible for some poor man to buy her, and the money which he pays for her can go into some fund to help the soldiers."

Dr. Beede then named the filly "Akicita-okiye-wiⁿ" ("She helps the soldiers") and placed on her a nominal price of $25.00. By common consent a certain earnest worker in war relief activities was allowed to purchase her at this price. All the people were pleased with the name which Dr. Beede gave the filly, and the remark was heard: "When she has a colt it will be Akicita-okiye-wiⁿciⁿca and we shall have a breed of horses celebrated as being the descendants of Akicita-okiye-wiⁿ."

There were several other songs composed on this occasion. One of these was arranged by some old women. The first three lines consisted merely of musical vocables, after which came the following lines:

Okícizé waná inajiⁿ	"Already the war is stopped,
Na é wawáci ktá wahiye;	And so I come to dance;
Ináziná waúⁿ ciktedo,	Stopped; so we rejoice;
Inázina waúⁿ ciktedo.	Stopped; so we rejoice."

The dancing, interspersed with pauses for speech-making and the giving of offerings, continued throughout the afternoon. At evening twilight a free communal feast was served to all, as is customary in connection with all public ceremonies and functions given by Indians. After the feast a period of conversation between acquaintances and friends was followed by more dancing and speech-making until midnight. The people then went home.

University of Michigan

TECUMSEH'S ILLUSIONS

PRESIDENTIAL ADDRESS

WILBERT B. HINSDALE

MY REMARKS will be in no sense an attempt at a biography of Tecumseh or of his brother, the Prophet. Neither shall I attempt a history of the Shawnee tribe, or try to add an item to the annals of the North-West Territory. The object at present is to bring to attention some peculiar traits and modes of mental action in the Indian race, strikingly manifest in the life of one of their great chiefs, who was also a prominent character in the earlier history of our country.

It is quite impossible to consider Tecumseh's actions apart from those of his brother, who is usually referred to as "the Shawnee Prophet." For the purpose of illustrating some of the phases of the subject comparisons are made of Tecumseh and the Prophet with other characters who have acted similar parts inside and outside Indian history.

Human society is organized around leaders. Owing to some impulse, probably unusual mental development augmented by uncommon energy, certain individuals come into ascendancy and by example, suasion, or dominating personality influence the wills and actions of their associates. By their speech and mannerisms they make public opinion, which is by no means an exclusive feature of the era of newspapers and pamphlets. Speechmaking and forums are older ways of creating sentiment than is the printed page. The ordinary members of a human group are passive and stagnate in the pools of the sluggish stream of life. This lethargy is more characteristic of unlettered people tied down by rigid formulas of custom, ritual, and taboo, but even they are capable of being tremendously aroused, and they may be

lifted, by autosuggestion or persuasive influence, into states of alertness and exaltation.

All the great Indian leaders, of whatever race, were, so far as we know, eloquent and rhetorical in their own languages. When Red Jacket, of the Senecas, was raised to the dignity of chief, his original name, Otetiani, "Prepared," was taken away from him, and in its place was bestowed the name Shagoiĕwāthă (Sagoyewatha), "Keeper-Awake," an allusion to his powers of eloquence.[1]

There were two types of leaders, the prophet and the politician. The one had more to do with the ways of the individual, present and future; the other with tribal, village, or federation activities, frequently of a military character. The prophet was variously referred to as medicine man, priest, sorcerer, *jessakkid*, or by the particular feature of the mysteries in which he specialized. The politician was one who by some personal merit or by force of character above the average became a leader, chief, sachem, or sagamore. The title, as well as the official duties, varied with the locality. Among the Algonquian tribes the chief usually exercised legislative, executive, and judicial powers, and frequently added to his official functions that of chief warrior, although usually there were civil chiefs and war chiefs. The priest or prophet and the chief or politician worked together more than present-day reformers and agitators do, or, as sometimes happens, the functions of both were united in the same person — a striking illustration of which is seen in the case of Joan of Arc.

In the public affairs of society, especially in those of the past, it is difficult to draw distinctions between religious and political reforms. The advent of a prophet was not a very rare occurrence among the Indians, owing to their great susceptibility to superstitious impressions. In 1763 Pontiac appears to have endorsed as a kind of "platform" the precepts, inculcated by the Delaware Prophet, which forty years later were in substance made the "planks" in the "bill of rights" of Tecumseh's brother, the Shawnee Prophet.

[1] Morgan, Lewis H., *League of the Ho-Dé-No-Sau-Nee or Iroquois*, two volumes in one (Dodd, Mead and Co., New York, 1904), p. 85.

The religious revivals, political mass meetings, and mob gatherings of our time are but faded vestiges of the crowd excitement of primitive people. The tom-tom is the grandfather of the brass band, and the ghost dance still survives in students' demonstrations and in street parades of the Salvation Army.

To understand fully the person whose purposes it is proposed to analyze, it will be profitable to sketch the tribal background against which his character is cast. One of the earliest historical habitats of the Shawnee Indians appears to have been in South Carolina upon the Savannah River, which takes its name from them. The tribe seems to have become separated, and that which was the main body before the end of the seventeenth century was found later in the basin of the Cumberland River in Tennessee and the southern part of Kentucky. The branch that was in South Carolina moved northward about 1692, and settled along the Delaware River. Those located upon the Cumberland were expelled by the Chickasaw and the Cherokee and, under the protection of the Delaware, removed to the headwaters of the Ohio, where the original immigrants from South Carolina had also found it convenient to take refuge. As the white settlements advanced across the Alleghenies, both the Delaware and the Shawnee migrated westward into Ohio; the Shawnee located at Chillicothe and in the vicinity of Piqua, which is famous as the birthplace of Tecumseh, who, so far as we may judge from extant accounts, was as fine a representative of the Mongoloid as ever lived in the United States.

The Shawnee were a restless, vigorous, and warlike people, fighting at times and again living peacefully with their neighbors. That they were sometimes the drivers and sometimes the driven is indicated by their winding and wandering paths through nearly every state between the Hudson and Mississippi rivers. Parkman says: "Their eccentric wanderings, their sudden appearances and disappearances, perplex the antiquary, and defy research." [2] They fought to the death with the Catawba of the Carolinas, quarreled at one time and lived in peace at another

[2] Parkman, Francis, *The Conspiracy of Pontiac and the Indian War after the Conquest of Canada* (Little, Brown and Co., Boston, 1910), 1: 36.

with the Cherokee, and, during their sojourn in Pennsylvania, had furious clashes with the Iroquois and other tribes of the state.

They took leading parts in the French and Indian War, Pontiac's War, the Revolution, and the War of 1812, with which conflict their organization, formerly so very energetic, began to disintegrate, and they melted out of the history of the North-West Territory. According to Drake, the Shawnee "are supposed to have caused the destruction of more property and a greater number of lives, than all the other tribes of the north-west united."[3] Further, he states that "no tribe of aborigines on this continent, has given birth to so many men, remarkable for their talents, energy of character, and military prowess, as the Shawanoe."[4] The fighting strength of the Shawnee was never numerically very great. According to Sir William Johnson, in 1763, at the close of the French and Indian War, they had about three hundred warriors.[5]

Some statements about the life of Tecumseh are likewise necessary to an understanding of the observations which I am attempting to elaborate. His family was true to the Shawnee traditions. His father, a chief, was killed in an encounter upon the Tennessee frontier (1788 89). A brother met death while fighting by Tecumseh's side at Fallen Timbers. A sister who, if we may trust fragmentary reports, was a noble Indian woman, had considerable to do in directing him into paths of rectitude according to the folk ways of their people. Another brother attained almost as much distinction as Tecumseh himself, although not as a warrior. Some accounts have it that his brother, Tenskwatawa, and Tecumseh were twins. There were two other brothers, of whom there are no records of deeds of any kind.

It was Tenskwatawa who became known as the Shawnee Prophet. His career makes a vivid and important chapter in the annals of the times. He had trances and in his spasms became almost lifeless. In his paroxysms he flew through the wide expanses of the limitless ether, with side trips to the Heaven and

[3] Drake, Benjamin, *Life of Tecumseh, and of His Brother, the Prophet; with a Historical Sketch of the Shawanoe Indians* (E. Morgan & Co., Cincinnati, 1841), p. 37. [4] *Ibid.*, pp. 59–60. [5] Parkman, *op. cit.*, p. 154.

the Hell he had heard about from the missionaries, and returned believing he had been everywhere.

In the spirit world he lifted the veil separating the past from the future. His fantasies were realities to him, and he was so persuasive and earnest about the scenes that had been visualized for him that his narratives were received by hundreds of the people as the words of life. The imputation that he was an impostor is unjust. Foolish as his marvelous claims are to us, anyone familiar with the workings of the mind of people of his grade of culture will concede that his was not an unusual type of character, but one engendered by a conspiracy of all the factors of environment and mental habit.

The Treaty of Greenville had left the Shawnee practically without any lands which they could call their own. They were forced to become squatters outside the boundaries defined by the treaty. The Prophet had set up a shrine, for his reformation took on a decidedly religious phase, with himself as the oracle. He located at Greenville, removed to other points, and finally became established upon the Wabash at the mouth of the Tippecanoe River. From this place he sent out missionaries as far as Lake Superior to the north, beyond the Mississippi to the west, and all over the Ohio country to the east. His rallying cry was: "All the lands for all the Indians." He preached: "We must return to the old ways. Whiskey is burning the hearts out of our people, and the corrupting habits of the whites are causing our death. Do away with the trader's goods. Return to the skins of animals for habiliments, and to bark and stone utensils. Have no guns. The bow and arrow filled the mouths of our ancestors; they can always supply our wants. Do not use the steel and flint for starting fire. Employ the old method and do not let your fire go out. Kill the dogs. Have but one wife. Never strike a man, woman, or child. Do not marry among the whites. All property must be in common. Kill witches and wizards, and stop the practice of magic."

In the meantime Tecumseh was forever eloquently harping about the inalienable, landed rights of the tribes and tribal unity and confederacy. People began to flock from near and distant

tribes to the Tippecanoe assembly, which was a kind of Indian Chautauqua. What, to begin with, was a sort of religious revival among the tribes under the Prophet, became, under Tecumseh, a political agitation of an aggressive, threatening character, but all the time Tecumseh claimed to be only upon the defensive. If he had not had encouragement from Canada his campaign among the distant tribes would have been less formidable, or, more probably, would never have been carried on at all.

Governor Harrison accused Tecumseh of attempting to federate the tribes and of forming an organized compact among them. To this Tecumseh replied that Harrison's people had had at first thirteen states and that there were now seventeen, to which he referred as the "Seventeen Fires." If it was for the good of the "Long Knives" — the Indian name to distinguish the Americans from the English, the French, and the Spanish — to have a union, then the red men might also derive benefit from the same methods. The Long Knives had set the example, and the tremendous efforts of Tecumseh were exerted to bring about cooperation and mutual reliance among the tribes in the territory under dispute, particularly that part lying north of the Ohio River.

Harrison, frequently more or less uncomfortable, surmised that the proposed Indian federation, with Tecumseh as leader and the Prophet as religious agitator, was to bring under one directing power all the available warriors from far and near in an attempt to block the further occupancy of the lands and to drive out those who had already come in and become established.

The particular contention about the territory north of the Ohio grew out of treaties older than that of Greenville. Tecumseh, seeing that he could not include within his plans all the lands west of the Allegheny Mountains, limited the field of his special energies to Ohio, Indiana, and territory north and west. He flew from place to place, north, west, and south, with almost the same celerity with which the Prophet claimed he had traveled through the spirit world in his trances. He went as far from his base as Iowa to the northwest, Alabama to the

south, and Florida to the southeast, pleading his cause and arousing enthusiasm and recruits almost everywhere. At an old Creek village, Tukabatchi, upon the Tallapoosa River, he met Big Warrior, the chief whom he failed to impress with his appeal. Tecumseh turned upon his heels, saying: "I will go back north. When I get to Detroit, I will stamp my foot upon the ground and every house in Tukabatchi will fall down."

A striking coincidence is that at about this time there occurred the earthquake of New Madrid upon the Missouri side of the Mississippi River, in the vicinity of which was situated Tukabatchi. The first shock was felt December 11, 1811. Tremors continued at intervals until the following February. It was by far the most devastating phenomenon of its kind that had occurred within the history of the country.

All the chroniclers who have written about Tecumseh's career have accepted as true the reports of his actions and the threat he made. Be that as it may, some of the inhabitants were killed and whole villages were destroyed by the violent undulations of the earth's surface. The Creeks were terrified and, influenced also by the English and Spanish traders, espoused the cause for which Tecumseh had pleaded.

Another striking event had occurred in the career of the Prophet five years before. By some means he had learned that an eclipse of the sun was to take place in the summer of 1806. As the time drew near he boldly announced that on a certain day he would prove to the people his supernatural authority by causing the sun to become dark. When the hour arrived and the earth passed into the gloom of twilight, Tenskwatawa, in the midst of the frightened Indians, pointed to the sky and said: "Did I not speak truth?" There were no more doubters. He was proclaimed the true Prophet and Messenger of Life.[6]

After the eclipse the reputation of the Prophet continued to grow until he made his fatal blunder during the time when Tecumseh was in the south in 1811. When he left to be gone some time, Tecumseh tried to impress upon his brother the importance of

[6] Mooney, James, *The Ghost-Dance Religion and the Sioux Outbreak of 1890, Fourteenth Ann. Rep., Bur. Am. Ethnol.*, Part II, p. 674.

maintaining a negative or non-committal attitude. He told him to perform no overt act and to attend strictly to his office as prophet and evangelist, adding that he himself would act the part of the messiah. There were coming to Tippecanoe all the time recruits to the reformation, and the crowds of Indians caused more and more uneasiness upon the part of the governor, who demanded an explanation and finally moved his army very near to the Prophet's town. Space does not permit mentioning any events in connection with the battle of Tippecanoe except one or two important ones.

Instead of playing for time and performing no overt act to challenge violence, as the shrewd Tecumseh would have done, in his overconfidence or stupidity the Prophet did not rely upon Delphian ambiguity, but permitted his followers to precipitate a battle. He told them to go into the fight fearlessly, that they would be fighting in clear daylight, that the Long Knives would be in total darkness, and that the bullets fired at them would fall to the ground and not strike them.

While the engagement was going on, early in the morning of November 7, 1811, the Prophet was dancing, making incantations, and shaking his rattles. His fight was lost. His cause crumbled in a breath. He instantly dropped from the high estate of a great man to nothingness. There may be a word to say for him in extenuation. The Winnebago, who had come from Wisconsin to visit him, wanted to have the test over. They could not await Tecumseh's return, and they urged the Prophet to permit the battle to commence.

Tecumseh had experienced the turmoils of the frontier all his life, with varying successes and failures, but there had been enough successes among them all to encourage him in persistent effort until the last act of his life's drama closed with his death. Like many another hero, he failed to see that the Master of Life of the white people and the powers of the unseen world of his own people always fought upon the side of the better soldiers, the more skilful leaders, and the superior military strategists.

He had led the Shawnee in the defeat of the allied tribes by Wayne, August 20, 1794, at the battle of Fallen Timbers, and

affairs went on with discouragement after discouragement until on September 10, 1813, Perry, with the "big canoes," outmaneuvered Barclay in the battle of Lake Erie, and he saw Harrison aggressively pushing the incompetent Proctor, his ally, across the Detroit River. He went into the battle of the Thames with the scales falling from his eyes and wishing, if the last glimmer of victory went out, that he might, as he did, expire with it.

One event that occurred in the War of 1812 must have given Tecumseh an exhilarating thrill of joy; that was seeing Hull's humiliating surrender of Detroit and Michigan territory to Brock, August 16, 1812.

The illusions that the inundating waters of the Long Knives could be kept from overflowing the north bank of the Ohio River, that the federation of the tribes might be sufficient to block the sweep of the Seventeen Fires across the Allegheny Mountains, that the guardian spirits would trick his opponents into his power, that an alliance with the British would help a little, had been dispelled one by one.

With the battle of Tippecanoe, which was unnecessary from the point of view of shrewd Indian sagacity such as Tecumseh had, but which the Prophet lacked, another of his illusions was snuffed out, that is, the hope that by some stratagem at the opportune moment, when Tecumseh could direct, the whites might be checked. Before Tecumseh returned from his tour of the south, but not long before his arrival at the old camping ground, the Prophet had foolishly fought and inevitably lost. Tecumseh saw at once that almost the last lingering hope of the consummation of his ambitions was gone. He turned upon the Prophet with violence, not only of language but of action, and threatened to kill him, but they lived together afterward, with brotherly love prevailing.

For a year or two, while the War of 1812 was threatening, Tecumseh had it in mind to ally his forces with the British should a war occur. He was not long in permitting himself to be wooed and won by Brock and Proctor. The British had for a long time furnished him equipment and commissary supplies. He had no love for his new military associates, and he detested Proctor

from the first. They were using the Indians as temporary means to a questionable end, and no one knew it better than Tecumseh, but his burning hatred for the Americans led him to the choice which he naturally made.

Tecumseh was bitterly opposed to the principle upon which the United States Government acted in making treaties. He vigorously maintained that all the lands belonged to all the tribes, not in severalty but collectively, that a valid surrender could not be made without the consent of all, and that the treaties negotiated, which disregarded this principle, were void. The Government, however, acted upon the theory that the Indians in occupancy at the time were possessors and that their consent to a contract, as signified by the marks of the chiefs present, constituted a legal relinquishment. At Greenville certain chiefs of bands of the Shawnee had indicated agreement to the treaty (1795), but not all the chiefs had done so, and not by any means had all the Shawnee known what was being negotiated at the conference. Black Hoof of the Shawnee and Little Turtle of the Miami, old warriors of a hundred fights, had become disillusioned, and gave up further opposition. Some of the Wyandot chiefs had done the same.

Notwithstanding that numerous courageous and dignified chiefs had become morose pacifists, Tecumseh held out, and with cogent eloquence and fearlessness told General Harrison that the whites "have taken upon themselves to say that this tract belongs to the Miamis, this to the Delawares, this to the Ottawas and so on. But the Great Spirit intended it as the common property of us all. . . ." [7] As to boundaries, he contended that the Great Spirit knew no boundaries, nor would his red children acknowledge any.

He further maintained that the negotiating tribes, like all others, were only transient residents. They were moving, interchanging, federating, and shifting so much from time to time that the lands belonged to no special group of proprietors, but to all the people of all the tribes, and that their unanimous consent

[7] Randall, E. O., "Tecumseh, the Shawnee Chief," *Ohio Arch. and Hist. Soc. Publ.*, 15 : 467.

to the transfer of their property had not been obtained, nor was it possible to obtain it.

Harrison said that the land was not the common property of all the tribes, but separable property of different tribes in possession of particular parts; that the president would insist upon separate tribal allotments of the land; and that the division would be supported, if necessary, by the sword.[8]

The Indians knew nothing about property in land. The lands, like the air and the big waters, were everybody's property and could belong to those in occupancy only as squatters. The terms "legal" and "illegal" were meaningless to them.

The claims of Tecumseh have never been regarded as valid by the nations of the earth who have taken possession of territory after discovery. Mahan has stated the accepted rule in the following terms: ". . . the claim of an indigenous population to retain indefinitely control of territory depends not upon a natural right, but upon political fitness, shown in the political work of governing, administrating, and developing, in such manner as to insure the natural right of the world at large that resources should not be left idle, but be utilized for the general good." [9] This is a rule perfectly consonant with the white man's code of morals, although in the wilderness of Indiana no one stopped to formulate it plausibly. It is the international understanding and makes Tecumseh's contention as to occupancy of lands a sad delusion. In general, it has been formulated after the accomplished fact as a rationalization and defense of the acts of the conqueror.

The conduct of Tecumseh in his relation with white people is usually regarded by those who write about him as having been simply political, but it does not show a full understanding of his character to say that he was only making forceful opposition to having his lands appropriated by strangers, and that his military operations were but an exacerbation in a continuous struggle that had had similar revivals since before the times of Powhatan

[8] *Ibid.*, 15: 468.

[9] Mahan, Alfred T., *The Problem of Asia and Its Effect upon International Policies* (Little, Brown and Co., Boston, 1905), p. 98.

and King Philip and down to and beyond the days of Pontiac and Little Turtle.

It is loyalty to one's native land to oppose the invader, by arms if need be, and Tecumseh's patriotism quite naturally led him to resent the presence of trespassers who had come with the avowed intention of remaining. There was a deeper motive in his conduct than appears upon the surface. He was fighting for the old ways, traditions, and beliefs, or a return to them so far as there had been departure from them.

With a mysticism characteristic of his race, which had also been inculcated by their priests and prophets for long generations, he, as other Indian leaders had done before him, looked into the future for the lasting betterment of his people through the assistance and intervention of some influence he believed in but did not understand, although in conference with the whites he vaguely called it, as they had taught him, the Great Spirit.

To attain the welfare of the tribes he realized that they must make the greatest offensive in their history. The forests were already going down by the axes of steel. Game was falling from missiles of lead. Plows were turning up the land into farms. Other brave chiefs had attempted, to use Tecumseh's own expression, to "dam the waters," only to meet disaster, but there had been opportunity for another rally. After this there could never be another chance to regain the lands already disposed of by treaties that no one understood except the beneficiaries.

Hope springs eternal in the red breast as in the white. He would make the supreme struggle. He would trust the guardian spirits of his ancestors, the ones that caused eclipses and earthquakes, that brought the sun in the morning, the moon in her season, the leaves and the flowers after the winter snows, and that fed and sheltered the people who were fighting upon his side against the white man's gods. He heard deep calling unto deep and allied himself with whatever and whoever would oppose the oncoming settlers north of the Ohio River. His becoming an "ally of the English for the sake of fighting the Americans was an incarnation of the traditional religion of his race, and he was seriously using his words in their literal sense when he said 'the

sun is my father, and the earth is my mother. On her bosom I will rest.'" [10]

His death put an end to the last formidable opposition to the opening up of the Old North-West Territory to settlement by the United States. The event has been described as follows: "The magnificent territory that the Indian had for centuries put to uses but little superior to those of the buffalo, the bear, and the wolf; that the Frenchman had used for purposes but little higher than those of the Indian; and that the Englishman had refused to use at all, was now to be devoted to the greatest of human objects — was now to become the homes of a progressive people excelling in all the arts of civilized life." [11]

Many but not all the prophets and messiahs like Tecumseh and his brother preached war as a means to their ends and perished in the fights they incited. Wovoka, the founder of the ghost dance, so called because everything connected with it related to the coming of the spirits or ghosts of the dead from the other world, was one of the exceptions.

The ghost dance was a doctrine of immortality and Wovoka was a millennial harbinger of an Indian earthly paradise in which the whole race, living and dead, would enjoy a beautiful hereafter in perpetual happiness and freedom from misfortune. In it there was to be no death nor old age, but plenty of buffaloes, feasting, and peace. To prepare for this estate there was a life of good behavior to live, ceremony to observe, and there were rituals to rehearse. In these formulas there were an ardent religious motive and a circumspect social and political conduct to be practiced.

There appears to have run through the history of reforms two types of messiahs and prophets, the militant ones and the princes of peace. Among those who attempted to enforce their reforms by physical means and to bring about a reversal of conditions are notably Mohammed, Joan of Arc, and Tecumseh. Wovoka, Gandhi, and the Shakers and Quakers represent the apostles of

[10] Carus, Paul, "Yahveh and Manitou," *The Monist*, 9 (Chicago, 1899): 406.

[11] Hinsdale, B. A., *The Old Northwest, with a View of the Thirteen Colonies as Constituted by the Royal Charters* (New York, 1888), pp. 281–282.

peace. Sometimes the aggressors have played the double part of priest and soldier, as did Gideon, the dreamer, who destroyed the Midianites.

The Hebrew warriors, whose ancestors were without letters, were a nomadic, non-agricultural people, upon about the same cultural level as our Navaho, but below that of the Pueblo.[12] Before going into battle they consulted the fetishes of Urim and Thummim or some acknowledged prophet. Similarly, the Shawnee Prophet danced, droned the victor songs, and shook the rattles during the fight at Tippecanoe. Sometimes the seer and the warrior have coöperated or followed each other, as did Pontiac and the Delaware Prophet. The two Shawnee brothers, each performing his separate part, worked together until Tenskwatawa, not being able to restrain himself till the fullness of time when Tecumseh should take the military or diplomatic aggressive, terminated his influence by precipitating the battle. If he had won at Tippecanoe, William Henry Harrison and John Tyler would never have become presidents of the United States.

It is interesting to note that Kanakuk, a Kickapoo of Illinois, also had interviews with the Great Spirit and received explicit instructions, the sentiment of peace running through them all. He was a non-combatant. The fundamentals of his preaching were to stop the drinking of white man's whiskey; to bow the head and not complain; to stop any attempt to take revenge, steal, murder, or tell lies; and to dispose of the fetishes of the medicine bag. His influence extended to the Pottawatomie of Michigan and had a very salutary influence through the Illinois country in 1827, when the Indians of that territory were being removed, under treaty agreements, across the Mississippi.

In order to understand the psychology of Tecumseh, it will be well to note a few historic parallels in which, under the influence of some leader imbued with what has seemed a supernatural power, an inferior or defeated people have made an effort to retrieve their fortunes. As a first example let me cite an uprising led by a Negro prophet.

In 1800 there was born upon a plantation in southeastern

[12] Mooney, *op. cit.*, p. 928.

Virginia a Negro who became known as Nat Turner. His owners, whose name was Turner, had always been kind and indulgent to him. He was exceedingly precocious and said he did not know how or when he had learned to read. He read a great many books and very early acquired an unusual comprehension of the sciences. His mother had been brought from Africa by the slave traders and was so wild and fierce that she had to be restrained from killing Nat when he was born, but she finally became a useful servant. The father was a high-strung, thoroughbred African who ran away when Nat was a boy, and was never recaptured. Nat was truthful, did not drink intoxicating liquors, was never caught thieving, and was in all ways a faithful and highly trusted slave until his last tragic acts.

Nat studied the Bible, preached, and became a violent fanatic. He was shown the things of the Lord and was, I should say, for want of a better term, a "retroactive" prophet; that is, without ever having been told things that happened before his birth he claimed to know them and could speak of them, and he convinced others that he could do so. His people were greatly astonished, for if the Lord had shown him these things he certainly must be a prophet. His master had noted his uncommon intelligence, and had assisted him in the acquisition of information. It was remarked that the singularity of his manners would probably destroy his usefulness as a slave.

Impressed with the consciousness of his own superior intellect, Nat sought seclusion and wrapped himself in mystery. As he worked in the fields between the plow handles, the spirit of the prophets of old whispered in his ear, and "knowing the influence he had obtained over the minds of his fellow-servants, by his austerity and air of mysticism, he determined to prepare the negroes for an uprising by telling them that something was about to happen which would fulfill a great promise which had been made to him." [13]

He appears to have thought of himself as a kind of messiah — a belief which is common among people who have been sub-

[13] Drewry, W. S., *Slave Insurrections in Virginia, 1830–1865* (Washington, 1900), p. 31.

jected to domination. He thought he beheld the hands of the Saviour extending to him from the clouds.

Space does not permit further account of Nat's preparations, trances, and hallucinations. In February, 1831, there was an eclipse of the sun which was the heavenly signal for active organization of the preconceived insurrection. Raids were organized, and blood began to flow before the people appreciated that it was possible for Nat's fanaticism to take active, violent form.

The insurgents did not hesitate to murder wantonly their own masters and overseers. On August 13, 1831, Nat thought he saw in the rising sun the sign to begin the execution of his plot. On the twenty-first he began to carry it out. As a result of the raids, which spread terror over Southampton County, Virginia, and along the border of North Carolina, over fifty-five white men, women, and children were murdered before the county and state officers were able to apprehend the Negroes, ten days after the outbreak. Nat Turner and his fellow-conspirators were hanged, and the most serious manifestation of religious fanaticism upon the part of Negroes in the United States came to an end.

An interesting variation in leadership of the oppressed is found in John Brown, who, although he may not have announced himself as a deliverer, attempted the part of one. His undertaking was peculiar because of the fact that he was of a different race and an entirely different social stratum from those of the people for whom he sought to be the shepherd. The Shawnee Prophet, Nat Turner, Joan of Arc, and Mohammed were of the same blood and bone, and sprang from the same social levels as the people they led. The termination of Brown's efforts was much like that of Nat Turner's - unless one assumes that the Civil War was precipitated by his acts.

An older example of the same psychological complex may be found in the Arab boy who tended sheep and goats and watered the camels; a priest, prophet, and king of a new order among his people, who has today 150,000,000 followers. Mohammed was of an unstable, nervous temperament. Some of his biographers affirm he was hysterical, perhaps cataleptic. He saw visions, heard voices and had flashes of poetic expression and, with

Gabriel as "sky-pilot," flew through the empyrean, visited heaven, and made a landing at Jerusalem, bringing back the manna of the divine spirit.[14]

His education was about the same as Tecumseh's. Carlyle says of Mohammed: "He had no school learning. . . . It seems to be the true opinion that Mahomet never could write." His biographer in the *Encyclopaedia Britannica* (14th edition) says that he probably could read and write, but unskillfully.

We know that "Tecumthe could read and write, and he had for his confidential secretary and adviser, Billy Caldwell (Sagaunash), a half-breed, an educated man, and subsequently head chief of the Pottawatomie nation." [15]

The two men, Mohammed and Tecumseh, had relatively about the same ability, although Tecumséh in many respects displayed, from the present-day point of view, the nobler character. They were both intensely sincere in their convictions. Tecumseh was physically more resolute. The time Mohammed spent in trances and visions, Tecumseh spent in organizing his few resources, leaving the communions with the spirit world to his brother, the Prophet.

With a belief in a single and true god, but not a god of his own creation, Mohammed fought and shed blood to displace the three hundred idols of Mecca. He struggled with people of his own type, culture, and racial peculiarity, and had available for support innumerable potential allies. Mohammed was a civil reformer among a very numerous homogeneous people who were not threatened with invasion. Tecumseh's task involved the uniting of antagonistic tribes, few in numbers, and separated by hundreds of miles, living in a state of modified savagery. They were socially in a low grade of culture, although armed with the same weapons as their adversaries. They had no conception of nationalism and could not hold as a barrier against civilized intruders who had come to build an empire. The analogy of the situation is only in a likeness in thought of the leaders, each of

[14] Clarke, J. F., *Ten Great Religions* (Boston, 1871), 2: 454–455.

[15] Perkins, J. H., *Annals of the West*, Second edition by J. M. Peck (St. Louis, 1850), p. 550.

whom imagined himself under the guidance of supernatural power partial to his own people. It was remarked, nineteen hundred years ago, that God had spoken unto mankind "at sundry times and in divers manners."

Tecumseh fought to vindicate the powers of life made manifest in all things, and to drive a foreign host, of a different race, from the domain of his people. His human resources were very feeble. He could make no alliances with anyone whom he could trust. He knew full well, after casting his lot with Proctor, that if they should be successful, eventually his English friends would turn and rend him. If he had had all the Indians then living in the United States, men, women, and children, in alignment, there would have been only about 900,000 of them altogether. From all the wide domain north of the Ohio River he could not have assembled 10,000 warriors because there were not so many. The scimitar in the hands of the Bedouins and the scalping knife in the hands of the Shawnee might balance in method one against the other. When it came to defending and befriending prisoners, women, and children, after a battle or any other attack, Tecumseh was furious in their behalf. No Christian soldier ever acted a more humane part under such circumstances than he did, a remark that cannot truthfully be made about the Great Prophet of Allah, who justified using low means for what he thought were good ends.

Dr. James Mooney compares Mohammed's genius with that of Smohalla of the Columbia River region, who went into long trances, received messages, and founded a sect called "Dreamers." [16]

Joan of Arc, perhaps the most remarkable, pathetic, and heroic instance of religious hallucinations in Europe, also belongs among the messiahs. She combined in her own personality the prophetess and the ability for military leadership. A peasant girl who heard voices, had visions, saw light, and believed herself under divine direction, she gained the confidence of bishops, princes, and soldiers, and, wielding a sword which she claimed came to her sanctified, commanded an army, liberated her country, and died at the stake at the age of nineteen, a conqueror and

[16] Mooney, *op. cit.*, p. 719.

a martyr. She appears to have had no particular advantage that came through education. She won by the earnestness and enthusiasm with which she put herself forward. If she were under the observation of a present-day physician, he would discover in her many reasons for adjudging her a fit person for clinical observation, demanding the attention of specialists in neurology, psychiatry, and diseases peculiar to women. "She was dreamy and shy; nor did she ever learn to read or write." [17]

In recent times the outstanding character of the messiah type is the East Indian, Gandhi, whose garb has a resemblance to the invulnerable ghost-dance shirts of the Sioux. His loin cloth and spinning wheel "are the symbols whereby he dramatizes the conflict which he is waging with a materialistic west." [18] Sincere, but with an ostentatious show of poverty, and suffering from a supposed burden of wrong imposed upon his kin, led by an inward light with a vision of a mundane, if not a heavenly, kingdom-come, in his behavior he reminds one of Wovoka, or Jack Wilson, the Paiute leader in the ghost-dance revival of 1888. Allowances must be made for the difference in the grades of advancement in the two cases, but the parallelism is strikingly discernible. It is the same inherent trait outcropping in human nature under similar tribal situations.

By his conduct Gandhi does not appear to have introduced into his campaign any new or peculiar features of either a religious or a political nature. He is merely emphasizing by conduct and precept characteristics of reform that have been practiced before for long centuries, and fortunate will be his passive revolution if some persons whose fanaticism takes a different bent from his own do not commit acts of violence like those which occurred when the ghost-dance doctrine crossed the Rocky Mountains.

Let comparison go a little further. The Shawnee Prophet and the Mahatma stand for home rule. The Prophet insisted that whiskey and all other intoxicants be rejected by his people.

[17] MacLaurin, C., *Post Mortem, Essays Historical and Medical* (George H. Doran Co., New York, 1922), p. 38.

[18] "Bethlehem: The Divine Drama," an editorial in *The Christian Century*, Dec. 23, 1931, p. 1614.

Gandhi insists that the opium trade be stopped and says that intoxicating drink is Satan incarnate. They each attempt to put religion into government. The fundamentals of the meek and the truth-telling East Indian may not be very clearly understood by the average Christian, but they probably are no more mystical and difficult of comprehension than the totem, manitou, clan system, and the Midewiwin of the Algonquian. The political control of the cotton of Lancashire, the return of the spinning wheel, free trade, and free evaporation of salt comport exactly with the urging of the tribes to abandon the use of the white man's flint and steel and to discard the trader's blankets for buckskin. Each reformer is a remaker of souls, the only difference being that the one had but the lights of an undomesticated man of the forest, whereas the other has the acquisitions of a culture that has taken on the additional complexes that are called civilization.

There seems to be little difference between the purport of Gandhi's statement that he wanted to avoid violence and that non-violence was the first principle of his faith,[19] and that of the founder of the ghost dance, Wovoka, who, in 1890, in the basin of Nevada, said: "Do no harm to any one. Do right always. . . . You must not fight." [20] These beautiful precepts indicate clearly that the Indian had had contact with missionary preaching from the Sermon on the Mount, and Gandhi's whole scheme for reform in the British Empire is an attempt at a rigid application of the same code.

No one doubts the sincerity and honesty of the prophets and messiahs. They believed in themselves and justified their means by the ends anticipated. Very few of those who have announced themselves the chosen ones of God, or who have visited the realms of the spirits, were impostors in the sense that they were using their alleged revelations for playing trickster or continually deceiving their followers. They were sincere characters, although, perhaps, they would have been fit subjects for clinical observation by a psychiatrist.

[19] Saunders, Kenneth, "Mahatma Gandhi," *Pacific Affairs* (March, 1931), p. 208.

[20] Mooney, *op. cit.*, pp. 782-873.

Whether Tecumseh regarded himself a chosen messenger direct from the spirit realm is questioned by writers who think only in terms of politics, but it is no doubt true that he was in sympathy with those who claimed to have revelations and that he yielded to what appealed to him as plausible predictions, especially in his earlier career. He thought himself a deliverer of his people. It is natural to overestimate qualities of persons who evoke our sympathies and admiration. Perhaps Tecumseh was not so noble as the reports about him lead one to suppose. They may be flecked with colors added by persons who have been a little romantic in their accounts. To find the real man one must always winnow away a little chaff and discriminate between the probable and the improbable. With these cautions in mind it is safe to affirm that he was a man of character possessing the forcefulness that we approve of in persons of our own race. Had he been environed in the same culture as the white people who opposed him, in worthiness of intention and an energy of purpose he would have shown himself superior to the most of them and equal to any. From the point of view of the philosopher who is always playing upon a harp of one string to the tune of material civilization, Tecumseh was a mere incident, but to him who contemplates humanity in its wholeness, from Cro-Magnon to people of today, and who discerns the marks of ability, though darkened by the shadows of a stone-age culture, there is a serious interest attached to his career, although his unstable union of the tribes, which after the subsidence of the Prophet was held together only by his own personality, in the nature of the case, crumbled like a robin's egg in the beak of a hawk. He was disillusioned when as a last hope he allied himself with the British, and that hope had faded before the battle of the Thames, which he entered wishing never to return should the field go against him. He put off the uniform and trappings of a British colonel, with which he had been decorated, put on the buckskin of his loyal band and died as he had lived, an Indian brave, not an officer in the service of the Crown.

It is not very much to the credit of the pioneers, either politically or from a military point of view, that they won the

battle of Tippecanoe or any other skirmish with the Indians who were few in numbers. Driving them from the frontiers or worsting them in any manner was like driving catamounts out of trees, wolves away from sheepfolds, or bears from storage pits. It had to follow from the augmenting numbers of invaders. A few thousand Indians could not stand for more than a generation or two against the ever-rising tide of palefaces.

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THE FAMILY AS A SOCIAL UNIT

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A FAMILY is "the group of persons consisting of the parents and their children, whether actually living together or not" (Murray's dictionary). The concept may be enlarged to embrace "those who are nearly connected by blood or affinity," but such expansion makes for greater vagueness. Adhering to the narrower definition, let us ask whether human society must a priori be constituted of family units. The answer is negative. There are sexually reproducing species without a semblance of family life, hence the segregation of husband, wife, and child into a distinct group remains to be empirically demonstrated. As a matter of fact, the existence of such a unit in early man has been categorically denied by many writers. In the beginning, we are told, was promiscuity — sexual license unchecked by any restraint. The earliest inhibitions prevented interbreeding of parent and child; they were followed by interdicts against the union of siblings (brother and sister); and so by a series of reformatory movements humanity finally attained the giddy heights of Victorian monogamy, at least in theory.

Unfortunately, we can know nothing directly about the sex life of man's immediate precursor, and a comparison of primate behavior, though definitely ruling out certain assumptions, offers a minimum of positive fact for the reconstruction of ancestral habits. A zoölogist, Mr. Gerrit S. Miller, Jr., has recently brought together what is known. He has proved that, contrary to a widespread misconception, virtually all the primates observed lack a rutting season. Accordingly, it is in the highest degree improbable that man's immediate forerunner mated seasonally. Like his fellow-primates, he was presumably ready to indulge in amours whenever an occasion arose. Furthermore, it seems that

recent human aberrations have their counterparts among primates, and their potentiality may thus well be a heritage from a fairly remote past.[1]

From available information, however, we can gather nothing to test the theory of early human promiscuity. Indeed, the field observations on the nearest anthropoids, chimpanzees and gorillas, are indecisive and at times contradictory as to the traits of the same species. Reichenow, for example, credits the gorilla with monogamous habits, while Akeley cautiously suggests the possibility of polygamy. "The truth is," he wisely adds, "that people know little about the habits of the gorilla." [2]

Yerkes, with exemplary restraint, makes the following statement: "Our tentative inference is that both monogamy and polygamy exist in one or another or all of the anthropoid types and that in all probability both relationships are discoverable in each of the manlike apes. With many misgivings we propose as order of increasing probability of monogamic relation: gibbon and siamang, gorilla, orang-outan, chimpanzee. Much more systematic, thorough, and critical investigation than has heretofore been conducted will be essential to discover the truth. Indicated as points of contrast among the three types of great ape are temporary monogamous or polygamous relations in the orang-outan, relatively permanent monogamous and possibly also polygamous relations in the chimpanzee, and in the gorilla a patriarchal family, with polygamy presumably in the mountain species and monogamy, possibly, in the lowland species." [3]

If we know nothing more positive about existing species, any dogmatic conclusion as to the behavior of a hypothetical, extinct ancestral type seems rash indeed.

[1] Miller, G. S., "Some Elements of Sexual Behavior in Primates and Their Possible Influence on the Beginnings of Human Social Development," *Journal of Mammalogy*, 9 (1928): 273–292; *idem*, "The Primate Basis of Human Sexual Behavior," *The Quarterly Review of Biology*, 6 (1931): 379–410. After writing this paper, I find that Miller's inferences are challenged by Dr. S. Zuckerman in *Social Life of Monkeys and Apes* (New York, 1932). The matter is one for zoölogists to decide.

[2] Akeley, Carl E., *In Brightest Africa* (Garden City, 1925) p. 247.

[3] Yerkes, Robert M. and Ada W., *The Great Apes, a Study of Anthropoid Life* (New Haven and London, 1929), p. 542 f.

On one point, however, we can be certain. Whatever may have been the mating habits of this or that precursor of *Homo sapiens*, no believer in evolution can deny a stage of promiscuity somewhere along the line, that is, of promiscuity in the technical sense of socially unrestrained lust. Anthropologically, there is no "index of promiscuity," calculated by dividing the number of actual mates, regardless of kinship, by the number of physically possible ones. From this angle, it is a question of "all or nothing." Is carnal desire checked in some of its manifestations by the disapproval of the group? If it is, there is no promiscuity; otherwise, there is. Take the case of a male gorilla which Akeley found with three females. The point is not whether the male cohabited with all three females. It is rather this: Assuming two of them to be his daughters, would the attitude of other gorillas be one of indifference or not? The situation is not inconceivable even on the human level. A widespread tale of Great Basin and Western Plains Indians revolves about this very theme. The trickster by his wiles gains access to his own daughters. In the story, however, such behavior arouses intense moral condemnation. Now, I, for one, fail to find evidence for such a social consciousness in either Koehler's [4] or other data from the infrahuman plane. If this interpretation holds, the anthropoids are promiscuous. On the other hand, no known group of *Homo sapiens* is indifferent to the sex behavior of its constituent members. Wherever evidence is adequate, matings are judged — outlawed, reprobated, condoned, accepted, or definitely sanctioned. The definitely sanctioned forms of mating may be termed "marriage," and from them evolves the family. Nowhere are fornication and marriage submerged in an undifferentiated category of animal-like "copulation."

A chasm thus yawns between *Homo sapiens* and the chimpanzee or gorilla. At what stage of evolution, then, was the leap taken from unjudged to judged sex behavior? I do not know. I venture a guess that Neanderthal man showed some discrimination. I so conjecture because he demonstrably had a social tradition as to craftsmanship, and it thus seems probable to me

[4] *The Mentality of Apes* (New York, 1925).

that he had likewise evolved norms of social conduct. I refuse even to guess whether Heidelberg man, Eoanthropus, Peking man, and Pithecanthropus displayed equal fastidiousness. I am content to believe that, somewhere between the more remote anthropoid ancestor and the more immediate hominid ancestor whose descendants constitute geologically recent humanity, there was a stage of uncontrolled sexual license.

I am not sure whether I agree or disagree with Mr. Miller as to the distance of this stage. He offers the argument that living samples of men are specialized survivors and that many races have become extinct. Hence, he infers, "the search among these specialized existing peoples for a race or tribe living under social conditions that represent anything closely resembling an unmodified reflection of man's primitive mentality can have little chance of success." [5] Here everything hinges on the meaning of the terms "man," "closely," "primitive mentality." I not merely admit but contend that Andamanese, Fuegians, Australians, and Chukchi tell us nothing definite about the mentality of Piltdown or Peking man. I emphatically insist that no one primitive group represents the first hominid's mentality in unmodified form. But if such highly specialized groups as Andamanese, Australians, and others, without exception exercise social control of sex life, then such control does not date back to yesterday nor, say, to 4000 B.C., but, presumably, to a period embracing the earliest samples of *Homo sapiens*, even though some of the races of this species are irrecoverably removed from direct observation.

Time does not permit detailed consideration of more than one recent human society. I shall select the Australians, whose anatomical inferiority and crudeness in the arts of life have made them a favorite starting point for speculative historians on the origins of the family, religion, and what not. Moreover, they have been credited with a form of sex life that might be viewed as intermediate between promiscuity and obligatory monogamy, viz., "group marriage." This institution has been defined as the non-preferential mating of a group of men with a group

[5] Miller, G. S., "The Primate Basis of Human Sexual Behavior," *The Quarterly Review of Biology*, 6 (1931) : 400.

of women. It would not represent promiscuity, inasmuch as Australians would never tolerate unions of brothers and sisters. But anyone who favors the theory of promiscuity in Aurignacian or Mousterian times would naturally regard that mixture of polyandry and polygyny involved in group marriage as a step toward increasing control of mating. On the other hand, so long as a whole group of men mated indiscriminately with a group of women, the family would remain non-existent as a social unit.

In the interests of concreteness I shall base my statement on what Professor Radcliffe-Brown describes as the clearest available account of Australian conditions, Warner's report on the Murngin living west of the Gulf of Carpentaria.[6] This picture I shall eke out with supplementary data on the Australians and shall then proceed to cull relevant data from the literature on other groups. The questions asked will include the following: Is there a form of marriage as distinguished from cohabitation? If so, what are the social relations of husband and wife? Of siblings? Of parent and child?

To begin with the Australians, no Murngin is free to mate with whom he pleases, and in marriage he is always expected to obtain the daughter of his maternal uncle. Failing such a one, a substitute of equivalent kinship status would be sought, for example, the daughter of a mother's male cousin. Potential spouses may be betrothed prenatally. To be sure, a man wants the maximum number of wives safely procurable, but they are never chosen at random. In order to make social intercourse possible for them at all, Australians always range individuals into kinship classes. So, even when the Murngin raid a hostile camp the kidnaped women are allotted to men standing to them in the socially approved relationship. Similarly, adultery is almost always with a cousin of the prescribed category. By a natural extension of these ideas, which rest on the social equivalence of siblings of the same sex, a brother inherits his elder brother's widow, and often the several wives of a polygynous husband are sisters or quasi-sisters.

Unquestionably there are "wrong" marriages among the

[6] Warner, Wm. Lloyd, "Morphology and Functions of the Australian Murngin Type of Kinship," *American Anthropologist*, 32 (1930) : 207–256.

Murngin, as among ourselves. Yet within certain degrees prohibitions are absolute and, apparently, never flouted. In other cases strong disapproval is voiced: a man who would carry on an intrigue with his "sister's daughter" — actually perhaps his third cousin's daughter — would be compared to a dog, and the woman would be liable to a severe drubbing.

Moreover, within the range of licensed unions a distinct ideal may be noted. A husband may have several wives, but he ought not to seek amours with other women; and a wife is normally expected to content herself with a single mate, her husband. The social relations of spouses, furthermore, assume definite rights and duties. A wife gathers wild fruits and small game; the man supplies fish, turtle, porpoise, dugong. Sentimentally, common devotion to the children constitutes a bond; and even apart from that factor indications are not lacking of an attachment reminiscent of romantic love.

In all this there is not the faintest suggestion of either promiscuity or group marriage. The parental relationship is extended so that a woman's sister may help her suckle two babies; and, in general, a child looks to a maternal aunt for food and care. This, however, develops quite naturally from the practice of sororal polygyny. But, though the principle of sibling equivalence holds, the immediate family group is distinguished. Thus, a childless husband observes food taboos, which are lifted with paternity, "but the child must be his own, not that of a brother." (The term "own" in this context will be discussed later.) It is the father who determines the type of initiation for his son, passes on the right to certain dances, and teaches the ceremonial routine. In short, a man takes a differential interest in "his" children.

The Murngin thus recognize a family unit, but that does not mean that it is *our* family pattern. A contrast at once appears with regard to siblings. Brother and sister can never be on terms of easy familiarity. A brother never sleeps in the same camp with her, and neither may address the other. Associated with such taboos we find the attitude of mutual helpfulness that to us seems altogether intelligible. A brother will give presents to his sister for her son and husband. Two brothers coöperate

in economic pursuits and have a sense of joint ownership of property. This naturally in a measure embraces wives, but with such qualifications as to exclude unchecked communism even between true brothers. No younger brother appropriates a sister-in-law without permission. The elder brother preëmptively claims his maternal uncle's daughters. When he has thus acquired two wives, the younger man has a strong *moral* claim on the next oldest sister of the household, and her father may urge the husband to waive his legal prerogative. Even here there is thus definite customary law, not license. But a brother's attitude cannot be the same as ours in a society which makes him look to his older brother as the provider of a mate, either after or during his lifetime.

The family picture would be further modified by the taboo, universal in Australia, forbidding all social intercourse between a man and his mother-in-law. Yet, notwithstanding the lavish use of such kinship terms as "father," "brother," etc., to embrace fairly remote kinsfolk, the immediate family group is clearly separated from the rest of the community. A prospective husband tries, first of all, to marry his "own" mother's "own" brother's "own" daughter; and the uncle provokes resentment if he marries off a daughter to a remote nephew.

We have seen that a married man's social status depends on his having "own" children. This distinction between near and remote kin of the same category holds throughout. Remote "brothers" ambush and slay one another, or at least suspect one another as potential adulterers; but between true brothers there is implicit trust and unfailing devotion. So in periods of ceremonial license distant, not "own," brothers participate in the temporary exchange of wives. Thus, at every step we stumble on clear-cut evidence for the aboriginal feeling that relationship to the next of kin is a thing *sui generis*. The resulting family is a bilateral unit since, from the child's angle, relations are maintained with both parental sides.

The condition described by Warner is not unique, but typical for the island continent. Malinowski's synthetic review [7] of the

[7] Malinowski, Bronislaw, *The Family among the Australian Aborigines; a Sociological Study* (London, 1913).

earlier literature and Radcliffe-Brown's more recent summary [8] leave no doubt on that point. Throughout Australia the nearest equivalent of our political unit, the state, is a localized "paternal lineage" or "horde" owning and exploiting in common a definite territory. Such a group embraces as a permanent core a number of brothers with their sons, sons' sons, and so forth. The women of the group normally come from another similarly constituted horde. Of the children the boys remain, acquiring from early childhood that intimate economic knowledge of the hereditary land which is a prerequisite to survival. The girls marry outside their horde, so that female children are only temporary constituents of the group into which they are born. Within this clearly defined horde, however, the aborigines recognize a lesser social unit, to wit, the individual family of parents and children. "The important function of the family," says Radcliffe-Brown, "is that it provides for the feeding and bringing up of the children. It is based on the coöperation of man and wife, the former providing the flesh food and the latter the vegetable food, so that quite apart from the question of children a man without a wife is in an unsatisfactory position since he has no one to supply him regularly with vegetable food, to provide his firewood, and so on. This economic aspect of the family is a most important one and it is partly this that explains Australian polygyny. I believe that in the minds of the natives themselves this aspect of marriage, i.e. its relation to subsistence, is of greatly more importance than the fact that man and wife are sexual partners. . . . sexual relations between a man and a woman do not constitute marriage in Australia any more than they do in our own society."

I believe that the picture our foremost authorities give of Australian conditions may be generalized for recent races of man. Twelve years ago I wrote: "The bilateral family is . . . an absolutely universal unit of human society." [9] These are strong words, but I still regard them as essentially correct. In only one area of the world am I able to detect phenomena tending

[8] Radcliffe-Brown, A. R., "The Social Organization of Australian Tribes" (Oceania Monographs, No. 1, 1931), esp. pp. 4, 6, 11 ff., 103, 107.

[9] Lowie, R. H., *Primitive Society* (New York, 1920), p. 78.

to qualify this view. In parts of Oceania, where adoption plays an extraordinary rôle, children are reported to divide their time more or less evenly between two homes, thus participating simultaneously in two family groups. I have recently taken cognizance of such facts, writing: "In this extreme form the custom [of adoption] inevitably modifies the principle of the universality of the individual family." [10] Let us note in passing that the exceptions occur in highly sophisticated horticultural societies which cannot possibly be regarded as illustrating primeval usage; and that the exceptions rest on a custom which by definition is derivative.

The general prominence of the family cannot, of course, be demonstrated without passing in review one primitive society after another, which space does not permit. I should like, however, to point out one rather significant North American phenomenon. If we examine the kinship systems of the rudest peoples in North America, the purely hunting tribes devoid of complex political, social, and ceremonial organization, we find that almost uniformly they distinguish in speech the immediate members of the family from the more remote kin. That is to say, while the Australians recognize the distinction in behavior, the simpler North American aborigines go so far as to express the sense of the difference in their vocabularies: a father is not only treated differently from an uncle, but is designated by a separate term; similarly, a brother is not included in the same term as a cousin; and so forth. The fact that the majority of non-horticultural tribes from the Arctic to northern California and Nevada fail to merge these relatives strongly suggests that the family unit is clearly recognized precisely on the lowest cultural level north of Mexico. It appears as though the family enjoyed undisputed ascendancy at a very early period, its significance being subsequently modified, though never abrogated, by other forms of organization. Thus, in Australia the partial equivalence of siblings of the same sex readily qualifies the character of the individual family, though its persistence is now demonstrated beyond cavil.

Terms for social units, such as "family," have misleading

[10] Lowie, R. H., "Adoption, Primitive," in *Encyclopædia of the Social Sciences*, 1 (1930): 459–460.

suggestiveness; therefore I shall try to indicate the empirical range of the data properly coming under this head. Let me first explain that the biological family is not necessarily identical with its social equivalent. A clever writer has recently credited me with a belief in the social omnipresence of the *biological* family. She contrasts with this the saner view of Radcliffe-Brown, who, while taking the biological group as the chief point of reference in a treatment of social organization, "gives due weight to more complex developments characteristic of many primitive societies."[11] Actually, there is no conflict; what is particularly important, both Radcliffe-Brown and I emphatically warn against attaching too much weight to the biological aspect of the unit. "Bilateral" and "biological" are not synonymous terms. When an Australian speaks of his "own" father, he does not necessarily mean his begetter at all, but the adult male whom he preëminently associated from infancy with a certain emotional behavior, economic activities on behalf of the household, and so forth. Elsewhere I have pointed out, on Rivers' authority, that among the Toda of southern India polyandry often makes the determination of paternity very difficult. But the natives do not care at all about biological paternity: that husband who performs a certain rite during his wife's pregnancy becomes *legal* father of all children borne by the woman until another husband goes through the same ceremony. "Biological paternity is completely disregarded, for a man long dead is considered the father of a child provided no other man has performed the essential rite."[12] So, in some South African tribes a man claims as his own legal issue the offspring of a duly purchased wife, even if she has for years been living in adulterous union with a lover. What counts, then, is not the biological but the legal kinship. The omnipresence of the bilateral family, then, means this: Virtually everywhere a male, who is not necessarily the procreator, and a female, who is not necessarily the bearer, maintain preferential relations to a given child or number of children, thus forming a distinct unit within any major social group.

[11] Mead, Margaret, "Family, Primitive," *ibid.*, 6 (1931): 65–67.
[12] Lowie, R. H., *Primitive Society*, p. 48.

The fact that substitutions for biological parental relations are possible and even relatively frequent is precisely one of the most outstanding revelations which ethnography has to offer to her sister science, psychology. For it sweeps away once and for all the assumption of a paternal *instinct.* In its place we must recognize a much vaguer tendency of adult males to form an attachment to infants of their species.

Toda and Bantu indifference to the identity of the procreator suffices to mark off their conception of the family from that traditional in Western civilization. To these natives the insistence on recognizing as one's children only those duly begotten by oneself must appear as ludicrously irrelevant physiological pedantry. Appraisal of the children's status may rest on quite different considerations. Among Northwest Californian Indians the equivalent of the Occidental bastard is the boy whose father failed to pay the customary bride-price, for with that blot on his escutcheon he is never permitted to enter the men's club house.

Socially, however, the family pattern is only moderately altered by the lack of interest in physiological bonds. For, in the examples cited, one male simply supersedes another as the embodiment of the paternal principle. In other words, a social tie of our own parent-child relationship category remains. That category may be more definitely affected by a maternal clan organization. Where such an institution occurs, the bond with the father and his kin is still recognized, but all children are, *for certain purposes,* reckoned as of kin only with the mother and, specifically, bear the name of *her* clan, not their father's. In this way may be set up a series of sentiments, of legal rights and duties, that come to compete with the parental ties and even enter into open conflict with them. By so doing they also inevitably clash with the family as an autonomous social unit. This appears most clearly where the avunculate holds sway. There the maternal uncle usurps, according to our notions, many paternal functions, and, correlatively, it is his uterine nephews and nieces that often stand to him in a relationship *we* regard as filial. Thus, he, and not the father, may dispose of a girl's hand; he, and not the father, will give certain kinds of instruction to boys; and, though in some

patrilineal African tribes, a man's son inherits his *father's* wives, barring only his own mother, certain matrilineal American and Melanesian groups permit a nephew to marry the widow of his mother's brother. To take a concrete case, a Dobu in Melanesia cannot bequeath his name, land, status, or fruit trees to his son; all of them are automatically inherited by a sister's son. A man may indeed teach his son what he knows of magical formulae; but to his uterine nephew he *must* convey such knowledge.[13]

Nevertheless, the sociological father is not abolished by avuncular customs. In the very region from which my last example is taken Professor Malinowski has demonstrated the depth of attachment linking father and son. The lurid and tragic conflict between paternal sentiment and avuncular duty has never been more vividly set forth.[14]

Another condition modifying the pattern of family life may be generalized under the head of "sex dichotomy," which manifests itself in many ways. Among the Australian Murngin we found the rather widespread custom of brother-sister avoidance, which at once precludes one of the most typical forms of family intimacy in our civilization. But we also saw that such usage does *not* snap the bond which links siblings together: brother and sister may not chat together, but they do aid each other, and the brother is keenly sensible of certain duties toward his sisters. Another type of dichotomy separates husband and wife. In many communities, for example, in South America and Oceania, spouses never eat together — an arrangement almost inconceivable to us. Yet the Banks Islanders of Melanesia go further. Among them virtually every adult male has bought his way into the men's club house, which is strictly tabooed to women, while the men not only lounge and work, but eat and sleep there, paying intermittent visits to their wives. Notwithstanding this institution, the family still holds together, so far as a husband exercises definite rights over his wife and is bound to her and the children by fixed

[13] Fortune, Reo, *Sorcerers of Dobu; the Social Anthropology of the Dobu Islanders of the Western Pacific* (Routledge, 1931), p. 15.

[14] Malinowski, Bronislaw, *Crime and Custom in Savage Society* (London and New York, 1926).

duties.[15] Generally, we may say that the universal sex dichotomy as to occupation is precisely a factor that fosters the family unit, for such division of labor, with its frequently correlated part-time separation as to companionship, obviously accrues to the advantage of the common household.

One other significant feature must be mentioned as modifying family relations. There may be segregation by age or status as well as by sex, or both forms of cleavage may be combined. Among the Masai of East Africa the bachelors occupy a separate hut, where they are joined by the young girls of the village with whom they consort apparently *ad libitum*. This is promiscuity in the popular but not in the scientific sense. For with meticulous care the Masai abstain from sex relations both with kinswomen and with their prospective wives, i.e. girls betrothed to them in infancy. And this once more accentuates the persistence of the family concept. For notwithstanding the license of the celibates' corral, it is definitely expected that every youth and maiden settle down in marriage after they have had their fling. Premarital freedom is followed by regular family life.[16]

In other areas, for example, in parts of Australia, only the boys are separated from the married couples. Usually this takes place after an initiation ceremony, sometimes at the age of seven. Relatively young boys are thus to some extent liberated from parental influence and subjected to the precept and example of somewhat older members of their own generation. In Samoa the unmarried are segregated from married folk in distinct male and female groups. The bachelors cultivate the soil, cook for the masters of the several households, and perform necessary communal tasks. The female counterpart embraces widows and wives of commoners as well as spinsters, and seems to have grown out of the custom of having companions of the same age groups and older chaperons sleep with a chief's favorite daughter.[17]

[15] Rivers, W. H. R., *The History of Melanesian Society* (Cambridge, 1914), 1 : 60–143; Codrington, R. H., *The Melanesians: Studies in Their Anthropology and Folk-lore* (Oxford, 1891), p. 101 f.

[16] Merker, M., *Die Masai. Ethnographische Monographie eines ostafrikanischen Semitenvolkes* (Berlin, 1910), pp. 44, 84.

[17] Mead, Margaret, "Social Organization of Manua," *Bernice Pauahi*

Again, among the Banks Islanders the men's club was divided into degrees, membership into each being acquired by purchase. Thus, there was a separation not merely of spouses, but of fathers and sons: normally a man would eat neither with his wife nor with his children, and a mother would be dissociated from her sons as soon as they had entered the club house, an act which was rarely deferred until adolescence.

I have thus not merely admitted but stressed the diversity of family patterns in recent human societies. This differentiation, however, virtually never militates against the principle that husband, wife, and child constitute a definite social unit set off from other like and unlike units in their community.

Lest the oddity of some savage arrangements make us lose our sense of perspective, it is well to recall historic changes in the concept of the "family" as held by civilized peoples. Certainly the Chinese are not lacking in a family sense, but it is coupled with notions foreign to us of wifely duty, of polygyny, and of concubinage. Scriptural patriarchs, too, were polygynous and concupiscent, but no one challenges the prominence of the family in Biblical times. Much nonsense is lavished nowadays on the destruction of the family by industrial civilization. Yet the legal ties between parent and child, husband and wife, are clearly recognized. What has happened is an alteration of the family ideals among large portions of our population. For better or worse, the change from rural to urban residence, the stress of economic conditions, an individualistic ideology, the partial abandonment of traditional religious doctrines have jointly affected the relationships involved in the family concept. In the latter half of the eighteenth century Dr. Samuel Johnson, that paragon of Christian piety, laid it down as a principle that "wise married women don't trouble themselves about infidelity in their husbands." He considered a woman who should turn the tables on an erring husband as "very fit for a brothel." These ideas, I believe, are no longer universally held with equal fervor. What I should like to point out is that between the upholders of a double

Bishop Museum of Polynesian Ethnology and Natural History, Memoirs, Bulletin 76 (1930): 14, 92 f.

standard and the modern sex egalitarians the difference is roughly like the difference between either and the Murngin or Banks Islanders. Only those iconoclasts would fall outside the common practice who should consign infants to communal baby farming and who would not tolerate any but quite temporary sexual attachments. Such societies have indeed been reported with much extravagance of vituperation, but with great frugality of proof.

A few conclusions of general interest may be summarized:

1. We know nothing whatsoever about the sex behavior of the immediate forerunner of modern hominids except that it very probably conformed to the generalized primate norm. Specifically, if Mr. Miller's summary is trustworthy, this implies the lack of a rutting season.

2. Though we cannot picture the sexual life of the protohominid, we may be sure that there was a stage of promiscuity, i.e. of socially unchecked sex activity. For, by definition, social checks are a characteristic of culture; hence before there was a culture there was, in the scientific sense, promiscuity.

3. All the unequivocally rude tribes of the world — Andamanese, Bushmen, Australians, Fuegians, Paiute — have a violent reaction against incest with the closest kindred. It is, therefore, extremely probable that this sentiment is of great antiquity.

4. Nevertheless, I no longer believe, as I once did, that incest is *instinctively* objectionable to man. On the one hand, I am assured on good legal authority that the criminal calendar of Western nations shows relatively many instances of paternal lust directed against daughters; and if only one tenth of psychoanalytic evidence is rated valid, the Oedipus complex remains as a factor to be reckoned with. As regards siblings, we have at least three historic cases in which the supposed instinct was deliberately set aside — ancient Egypt, Peru, Hawaii. In each of these aristocratic societies no mate was considered more appropriate for a ruler than his own sister, the only one, evidently, who fully shared his illustrious pedigree.

The aversion to incest is, therefore, best regarded as a primeval cultural adaptation which certain individuals potentially or actually override in all societies and which certain sophisticated

societies have expressly disregarded in the interests of an inflated sense of aristocratic lineage.

5. There is no parental instinct. No man can know instinctively that he is the begetter of an infant presented by his wife. Demonstrably, savage men in many and diverse societies utterly and deliberately ignore the question of physiological relationship while emphasizing that of sociological kinship. The maternal sentiment seems to rest on a firmer basis. Actually, economic pressure or the desire to avoid the shame of an illegitimate birth may be stronger. Among the Murngin, "Sometimes a mother kills her newborn babe because it has followed too closely to her others and she has not enough milk to feed it." Here, as well as in many other savage communities, the superstitious objection to twins invariably leads to the immediate killing of at least one of them.

What is of course universal in the interests of group survival is a generic interest of adults in children. This sentiment, however, as we have just seen, is not manifested by all members of the species uniformly, but may be ignored by the superior force of utilitarian rationalism or ideological irrationalism.

6. Every known society distinguishes between mere cohabitation and that socially approved form of relatively permanent cohabitation known as marriage. It may not be superfluous to point out that, as there is social fatherhood without the notion of procreation, so there is frequently social wifehood without physiological relations. A man may inherit a woman so old that she is unfit or undesirable from a sexual point of view; nevertheless, she would engage in the feminine occupations with the other women of the household and would be entitled to protection and care on the part of its master. To cite a concrete case, among the Manyika of East Africa a woman becomes the property of her elder sister's eldest son. "He does not cohabit with her, but otherwise has complete control over her. He may keep her at his kraal, where she does the usual woman's work for him. She has no recognized husband, but is encouraged to have a lover or even several." The children from such unions, it is interesting to add, are in no way under the tutelage of their biological father,

but are wards of the man who inherited their mother; he, and he alone, receives the girls' bride-price and provides the boys with the wherewithal for acquiring a wife.[18]

7. Apart from minor modifications or rare and highly localized deviations, the family based on marriage is a quite general phenomenon in known samples of *Homo sapiens*. A man socially functioning as a father and husband practically everywhere combines with a woman functioning as mother and wife to provide for their common household and the children begotten by them or by legal fiction reckoned as their offspring. Since this pattern is common precisely to the unequivocally rudest known tribes, it is presumably one of great antiquity in *Homo sapiens*. How far back it goes in his history and to what extent it even antedates him, no one knows.

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[18] Bullock, Charles, *The Mashona; the Indigenous Natives of S. Rhodesia* (London, 1928), p. 65.

NOAH'S ARK AND THE FLOOD: A STUDY IN PATRISTIC LITERATURE AND MODERN FOLKLORE*

EUGENE S. McCARTNEY

ONE of the greatest short stories of the ages is that of Noah and the flood. With kaleidoscopic rapidity there follow one another the events of a hundred years: God's decision to punish man for his sins, the building of the ark, the gathering of the animals, the cataract of the heavens, the destruction of all life outside the ark, the long days upon the water, the sending forth of the birds, the rainbow, and the covenant.

The Hebrews had an unerring instinct for picturesque narration, and it is to their credit that they realized the possibility of embellishing the less vivid tales which they found among the Babylonians. The simple but graphic Biblical account of the flood has never lost its hold upon mankind. Naïve people of many nations are still filling in details.[1] In fact, the Jews have never ceased adding strokes to the picture, for it takes about ten pages for one author to record the accretions with which he is familiar.[2] Among the Greeks we find Origen, who allocates various parts of the ark to suitable purposes, ingenuously stating that certain details in his description are not contained in the Bible, but are preserved by

* Migne's *Patrologia Graeca* and *Patrologia Latina* are referred to by the abbreviations *P. G.* and *P. L.*, respectively.

[1] See, for example, Dähnhardt, Oskar, *Natursagen: Eine Sammlung naturdeutender Sagen, Märchen, Fabeln und Legenden* (B. G. Teubner, Leipzig und Berlin, 1907–12); Sébillot, Paul, *Le Folk-lore de France* (E. Guilmoto, Paris, 1904–7).

[2] Ginzberg, Louis, *The Legends of the Jews*, translated by Henrietta Szold (The Jewish Publication Society of America, Phila., 1909—), 1 : 157–167. The sixth volume was published in 1928, but it seems that the series has never been completed.

tradition, and that the Bible maintains silence about things concerning which our reason may sufficiently instruct us.[3] It has always been fancy, however, rather than reason, which has added touches to the Biblical narrative. One Negro story has modernized the ark and equipped it with a steam engine.[4]

Though the account of the flood is written with engaging simplicity, it has not always found sympathetic readers. Even in antiquity there were many persons who were disposed to spoil a good story by asking matter-of-fact questions.[5] St. Cyril [6] is bitter against those who consider Christian teachings mere trifles and tales, and he singles out two men whose accounts of floods are not in accordance with the Biblical tradition.

THE SIZE AND SHAPE OF THE ARK

In giving Noah instructions about the dimensions of the ark God said (Genesis vi. 15): "The length of the ark shall be three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits." [7]

People of a practical turn of mind questioned whether an ark of such a size could hold all the animals and all the provisions necessary for a whole year's stay in it.[8] A way out of the difficulty was proposed by Origen, who said that Moses, whom he regards as the author of Genesis, was learned in the wisdom of the Egyptians and that the cubit in his account was the geometrical cubit,

[3] *In Genesim Homilia II* 1 (*P. G.*, 12.163).

[4] Bradford, Roark, *Ol' Man Adam an' His Children* (Harper & Bros., New York, 1928), pp. 26–33.

[5] See, for example, Origen, *In Genesim Homilia II* 2 (*P. G.*, 12.163), where it is stated that many questions were raised about details of the story of the ark. Later parts of this reference (*P. G.*, 12.165) are informative. See also St. Augustine, *De Civitate Dei* 15.27 (*P. L.*, 41.473–476).

[6] *Contra Julianum* (*P. G.*, 76.514): Verum quia nonnulli superstitiosorum nostra omnia dictitant futiles nugas et fabulas esse, nullam neque veritatis neque probabilitatis speciem prae se ferentes, necessario de illorum quoque scriptoribus, puta, Alexandro Polyhistore et Abydeno mentionem faciam. . . . I have used the Latin rendering for typographical convenience.

[7] In his account of a flood Alexander Polyhistor makes the craft of Xisuthrus five stadia long and two wide. See Eusebius, *Chronica* 1.3 (*P. G.*, 19.114).

[8] Origen, *In Genesim Homilia II* 2 (*P. G.*, 12.165). In this reference the conclusion of objectors is that the story is fiction.

which was six times as long as that of the Greeks.[9] To other objectors who held that such an ark could not be fabricated St. Augustine [10] retorted that cities of larger size had been built. In addition, Noah had a hundred years in which to do the work.

Again, the ark had three stories, so that the floor space was greatly increased. It was not tripled, however, for, although the Bible is silent on the point, common sense leads one to conclude that the ark was narrower at the top in order to help in shedding rain and to give greater stability to the boat.[11]

St. Augustine says that the ark had no curving lines, but was rectangular (see Pl. I).[12] He doubtless knew that the Hebrew word for "ark" means "box." [13] He also recognized that no mere man, depending upon his own guidance and skill, would dare to put to sea in a craft of this type.[14] If, however, the vessel was unstable, the square timbers of which it was composed were not, for St. Augustine regards them as symbolizing the firm and steady lives of the saintly, since whichever way one turns them they are quadrate or square.[15]

On some large bronze coins struck by the magistrates of the Phrygian town of Apamea during the reigns of Septimius Severus, Macrinus, and Philip I the ark is supplied with a lid (Pl. I). Noah and his wife are seated within. A raven is perching on the lid, and a dove with a twig in its mouth is flying toward the ark. By a convention not rare in ancient art a second incident in the same story is represented, and the rescued pair are shown after disembarkation, with hands upraised in an attitude of prayer.[16]

[9] *Ibid.* (*P. G.*, 12.165, 167). See also St. Augustine, *De Civitate Dei* 15.27 (*P. L.*, 41.474); Bede, *Hexaemeron Liber II* (*P. L.*, 91.92).

[10] *De Civitate Dei* 15.27 (*P. L.*, 41.474).

[11] Origen, *In Genesim Homilia II* 1 (*P. G.*, 12.161, 163).

[12] *De Civitate Dei* 15.27 (*P. L.*, 41.475).

[13] See Hastings, *Encyclopaedia of Religion and Ethics*, 4 : 546, *s.v.* "Deluge." The word employed in the Septuagint and the New Testament means "coffer" or "chest."

[14] *De Civitate Dei* 15.27 (*P. L.*, 41.475).

[15] *Ibid.* 15.26 (*P. L.*, 41.472).

[16] See Pilcher, E. J., "The Jews of the Dispersion in Roman Galatia," *Proceedings of the Society of Biblical Archaeology*, 25 (1903) : 225–233; 250–258. For the literature on these coins see Cook, A. B., *Zeus: A Study in Ancient Religion* (Cambridge, The University Press, 1925), 2 : 610, note 9.

To distinguish this Apamea from other towns of the same name it was called Apamea Kibotos, "Apamea of the Chest." [17] The justification for the use of the designs on the coins was found in

Fig. 1. A sketch on a Greek vase, showing Danaë and her infant son Perseus being shut up in a chest preparatory to being set adrift. Reproduced from Th. Schreiber, *Atlas of Classical Antiquities,* Plate LXXIII, Figure 6

the fact that folklore had very deftly transferred Mount Ararat from Armenia to Phrygia.[18]

It is held that the designs were inspired solely by the narrative in Genesis,[19] but it may not be out of place to note that chests were the traditional vessels in which Greek and Roman heroes and

[17] Pilcher, *op. cit.*, p. 227.

[18] We are told in *Oracula Sibyllina*, 1.261–262, that at the headwaters of the Marsyas River in Phrygia there was a mountain called Ararat, where the ark remained as the waters subsided. See also Pilcher, *op. cit.*, p. 250, and the reference to Julius Africanus in note 89.

[19] Pilcher, *op. cit.*, p. 258.

heroines were set adrift, for example, Auge and Telephus by her father Aleus;[20] Danaë and Perseus by Acrisius[21] (see Fig. 1); Dionysus and his mother by Cadmus;[22] Oedipus by King Laius,

Fig. 2. A relief from the Roman catacombs, showing Noah and his wife both in the ark and upon dry land. Reproduced from *Mélanges d'archéologie, d'histoire et de littérature*, 3 (1853), Plate XXX

according to some reports;[23] Rhoeo, the mother of Anius, by her father Staphylus;[24] Tennes, alone or with his sister, by Cycnus.[25]

[20] Strabo 13.1.69. See Usener, H., *Die Sintfluthsagen* (F. Cohen, Bonn, 1899), p. 87, note 1.

[21] Apollodorus, *Bibliotheca* 2.4.1; Hyginus, *Fabulae* 63. A coin of Elaea shows a woman, presumably Danaë, in a chest that has been found by four fishermen. See Roscher, W. H., *Ausführliches Lexikon der griechischen und römischen Mythologie*, 1 : 948, *s.v.* "Danae."

[22] Pausanias 3.24.3. See Usener, *op. cit.*, pp. 99–100.

[23] Scholium on Euripides, *Phoenissae* 26, 28. See Usener, *op. cit.*, p. 90, note 2.

[24] Diodorus 5.62. See Usener, *op. cit.*, p. 97, note 2.

[25] Diodorus 5.83; Pausanias 10.14.2. See Usener, *op. cit.*, pp. 90–91, note 3. For an infant set adrift in an *arca* see Livy 27.37.6.

Thanks to an elaborate description by Pausanias,[26] the most celebrated chest is that in which Cypselus was concealed by his mother.[27] Even the vessel of Deucalion is sometimes called a chest.[28] The receptacle in which Osiris was committed to the sea is likewise described as a chest.[29] With such forerunners it was almost inevitable that the artists of the Roman catacombs would represent the ark as a box [30] (Pls. II–III). In fact, a relief from the catacombs shows the two scenes depicted on the coins of Apamea [31] (Fig. 2).

The size of the ark has proved a matter of more than academic interest. "In 1609, Peter Jansen of Horn in Holland built a vessel of the same proportions, and found that it would stow one-third more cargo than other ships of ordinary structure. It has been calculated that it would contain a space of 3,600,000 cubic ft., and that after $\frac{9}{10}$ had been set aside for storage of food, there would be over 50 cubic ft. each allowed for 7000 pairs of animals." [32]

[26] 5.17.5–19.9. For a lengthy discussion of the chest see H. Stuart Jones, "The Chest of Kypselos," *The Journal of Hellenic Studies*, 14 (1894) : 30–80. Various scenes are reconstructed on the plate that accompanies the article.

[27] Plutarch, *Moralia* 163 F–164 A; Herodotus 5.92.4.

[28] Apollodorus, *Bibliotheca* 1.7.2 (see Frazer, *ad locum*, for other references); scholium on Pindar, *Olympiaca*, 9.62b.

[29] Plutarch, *Moralia* 356 C, E, 357 A.

[30] See illustrations in Wilpert, J., *Die Malereien der Katakomben Roms* (Herder, Freiburg im Breisgau, 1903), Plates 16, 56, 60, 73, 98, 104, 166, 172, 186, 187, 196, 212, 266.

[31] See Lenormant, Ch., "Des signes de Christianisme qu'on trouve sur quelques monuments numismatiques du III^e^ siècle," *Mélanges d'archéologie, d'histoire et de littérature*, 3 (1853) : 196–202, and Plate XXX. It now seems ridiculous that scholars had to prove that the scenes on the coins of Apamea represent the Biblical flood.

[32] Hastings and Selbie, *A Dictionary of the Bible*, 1 : 149, *s.v.* "Ark of Noah." Another ark had been built almost a century before Jansen's. See Tylor, E. B., *Primitive Culture* (G. P. Putnam's Sons, New York, 1920), 1 : 131: "Towards 1524, Europe was awaiting in an agony of prayerful terror a second deluge, prophesied for February in that year. As the fatal month drew nigh, dwellers by the waterside moved in crowds to the hills, some provided boats to save them, and the President Aurial, at Toulouse, built himself a Noah's Ark." In 1931 an ark was made at Olympia, Washington, in anticipation of the destruction of the Pacific Coast cities by a flood. A picture of it under construction appeared in the *Mid-Week Pictorial of the New York Times Company*, August 1, 1931, p. 5.

THE NUMBER OF ANIMALS OF EACH KIND

According to Genesis vii. 15 there went in unto Noah "two and two of all flesh, wherein is the breath of life," but the original commands are given thus in vii. 2–3, which is based on the Jahwist document:

> Of every clean beast thou shalt take to thee by sevens, the male and his female: and of beasts that are not clean by two, the male and his female.
>
> Of fowls of the air by sevens, the male and the female; to keep seed alive upon the face of all the earth.

One ancient doubter [33] concludes that there were two males and two females of each unclean kind of animal and seven pairs of the clean animals. He asks how space could possibly have been provided for four elephants, not to mention other animals. There must have been a common tendency to double the number of animals of each species in the ark. Bede [34] opposes it and explains that when God said two by two he meant not twice two of each species, but just two, the male and the female. Like most of us, he thought that there were not seven pairs of clean animals, but seven individuals, which left one unmated animal when they issued from the ark. He explains that it was intended as a sacrifice.

St. Jerome [35] says that only the male and the female of unclean beasts were taken into the ark, so that there might be no bigamy. Among the unclean animals are serpents, crocodiles, and lizards.

There is no doubt that some ancient critics pointed out the difficulty of making animals from different places and of many temperaments approach the ark quietly. Bede [36] states that they

[33] A certain Apelles, as quoted by Origen, *In Genesim Homilia II* 2 (*P. G.*, 12.165).

[34] *Hexaemeron Liber II* (*P. L.*, 91.93–94). Part of the reference is as follows: Quod ait septena septena, non in singulis generibus bis septena, sed septem solummodo tolli vult, e quibus unum quod paribus supererat post diluvium Deo posset offerri.

[35] *Epistola 123* (*P. L.*, 22.1054): Etiam de immundis animalibus bina sumuntur, masculus et femina, ut ne in bestiis quidem serpentibusque crocodilis ac lacertis digamia haberet locum.

[36] *Hexaemeron Liber II* (*P. L.*, 91.95): Cuncta ergo animantia uno eodemque die ingressa sunt in arcam, quia non Noe laboravit ea multo labore ac longo tempore colligere atque introducere vel minare in arcam; sed divino nutu

entered on one and the same day, and that Noah did not have to struggle with them or even to threaten them. At the divine command they advanced without causing trouble, and also in the proper number.

NOT ALL ANIMAL LIFE REPRESENTED IN THE ARK

There entered the ark "every beast after his kind, and all the cattle after their kind, and every creeping thing that creepeth upon the earth after his kind, and every fowl after his kind, every bird of every sort" (Genesis 7. xiv).

As the ancients became more familiar with the physical universe and began to realize that there were countless forms of animal life, they questioned whether all could have had ancestors in the ark. They asked not only whether small animals such as mice and newts entered the ark, but also whether insects such as locusts, beetles, flies, and fleas did so.[37]

The interpretation of the Scriptures, whether made by a learned theologian or by a colored preacher, naturally depends upon the amount of information the expositor brings to his task, and this in turn may hinge upon the character of scientific knowledge available.

The ancients, scientists and others, attributed to spontaneous generation the origin of almost all creatures with whose life-history they were unfamiliar. Insects were supposed to originate from many kinds of decaying vegetable and animal matter, from snow, rain, or a damp, languid heat, fire, foul water, slime, old wax, dust, paper, and even from books.[38]

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coacta, sponte cuncta veniebant in suo quaeque numero, praecedente illo cum liberis suis et uxoribus, sequebantur ex ordine, ac suas mansiunculas, Domino agente, quasi propria sponte subibant.

[37] St. Augustine, *De Civitate Dei* 15.27 (*P. L.*, 41.475): Quod autem *scrupulosissime quaeri solet de minutissimis bestiolis*, non solum quales sunt mures et stelliones, verum etiam quales locustae, scarabei, muscae denique et pulices, utrum non amplioris numeri in arca illa fuerint quam qui est definitus cum hoc imperaret Deus. . . . The words in italics show how literal-minded believers as well as doubters might be. Insects that might be described as *minutissimae bestiolae* would be almost microscopic.

[38] For numerous references see McCartney, E. S., "Spontaneous Generation and Kindred Notions in Antiquity," *Transactions and Proceedings of the American Philological Association*, 51 : 101–115.

By an adroit use of this belief in spontaneous generation and by an ingenious interpretation of Genesis St. Augustine proved that the perpetuation of insects was not dependent upon their entry into the ark. God commanded Noah to take into the ark both male and female. Since there were no males and females of living things which sprang from putrefying matter, there was no necessity for insects to accompany larger forms of animal life into the ark.[39] Even the most valuable of insects, bees, were not admitted,[40] because the ancients knew nothing of their nuptial flights.

The arguments advanced by St. Augustine may not have been entirely original with him, for after the flood of classical tradition all forms of animal life below man were restored by spontaneous generation.[41] It was quite natural, however, for St. Augustine to think of spontaneous generation in connection with the flood. He and other Christians debated whether God created all forms of insects in the original creation or whether they came into being only after animal and vegetable matter had begun to putrefy.[42] A much later writer concludes that God created only "potentially and materially" the insects that sprang from animals, especially dead ones.[43] Eustathius Africanus [44] explains the text, "Let the earth bring forth," by rehearsing time-honored notions about spontaneous generation.

Toward the end of the fifteenth century it was believed that the May bug had not been included in the ark: [45]

> In the year 1474, the may-bug committed great depredations in the neighborhood of Berne. When the authorities of the city had sought relief from the bishop of Lausanne, Benoît de Montferrand, against this scourge, he determined to issue a letter of excommunication, which was solemnly read by a priest in the churchyard of Berne. "Thou irrational, imperfect creature, thou may-bug," thus the letter commenced, "thou whose kind was never enclosed

[39] St. Augustine, *De Civitate Dei* 15.27 (*P. L.*, 41.475).
[40] *Ibid.*
[41] Ovid, *Metamorphoses* 1.416–437: cf. Mela 1.9.1, 3.
[42] St. Augustine, *De Genesi ad Litteram* 3.14.22–23 (*P. L.*, 34.288–289).
[43] Peter Lombard, Liber 2, Distinctio 15.4 (*P. L.*, 192.682).
[44] *P. G.*, 30.959: cf. Basil, *Hexaemeron Liber IX*, 2 (*P. G.*, 29.189, 192).
[45] Rydberg, Viktor, *The Magic of the Middle Ages*, translated from the Swedish by A. H. Edgren (Henry Holt and Co., New York, 1879), pp. 75–76.

in Noah's ark! in the name of my gracious lord, the bishop of Lausanne, by the glorified Trinity through the merits of Jesus Christ, and by the obedience you owe the Holy Church, I command you may-bugs, all in common and each one in particular, to depart from all places where nourishment for men and cattle germinates and grows."

Inasmuch as *muli* and *mulae* do not have offspring, since they are hybrids, it would have been superfluous, according to St. Augustine,[46] to include them in the ark. By literalizing to the utmost the phrase "every creeping thing that creepeth upon the earth," he barred not only creatures that live under water, such as fish,[47] but also those that float upon it, as some birds do.

St. Augustine's quaint reasoning about hybrids has a good modern parallel in English folklore. A Durham lad explained that "the magpie was a hybrid between the raven and the dove, and therefore, unlike every other bird and beast, had not been baptized in the waters of the deluge." [48]

The phoenix has been excluded from the ark by Germans for several reasons. One is that it was "a single, unmated creature" and another that it sprang from ashes.[49]

Modern lore represents the Devil as saying to Noah: "It's bound to clear up." [50] If we may trust a Yorkshire saying, a Pudsey man declined Noah's offer of a passage because the fare was too high.[51] In the "Miller's Tale" [52] Chaucer depicts Noah

[46] *De Civitate Dei* 15.27 (*P. L.*, 41.475–476).

[47] It is not without interest that at the famous Scopes trial Bryan testified under cross-examination that all animals outside the ark perished in the flood except possibly fish. Fish had previously inspired some humor in connection with the flood. About 1760 Voltaire learned of the finding of marine fossils in elevated districts of Europe. Fearful that the discoveries would be regarded as confirmation of the Biblical account of the flood he combined wit and wisdom "to prove that the fossil fishes were remains of fishes intended for food, but spoiled and thrown away by travellers; that the fossil shells were accidentally dropped by crusaders and pilgrims returning from the Holy Land. . . ." See White, as cited in note 49, 1 : 229.

[48] Henderson, Wm., *Notes on the Folk-Lore of the Northern Counties of England and the Borders* (London, 1879), p. 126.

[49] See White, A. D., *A History of the Warfare of Science with Theology in Christendom* (D. Appleton and Co., New York, 1896), 1 : 39.

[50] Benham, W. G., *A Dictionary of Classified Quotations*, p. 543.

[51] *Ibid.*

[52] "Tales of the First Day," 3538–3544.

as experiencing trouble in getting his wife to enter the ark. He would have liked her to have a ship to herself.

Such items of popular lore show how the thoughts of simple-minded people love to dwell upon the story of the ark. It may, perhaps, be worth while to quote in this connection an aetiological story from a book for children,[53] since it conveys some suggestion of the frame of mind in which folk beliefs originate.

WHY THERE ARE FOSSILIZED PRE-HISTORIC ANIMALS

And there came [to the ark] even the huge dinosaurs, for in those days were mighty beasts. But they were too big for the door, and could not squeeze in.

Now Noah sorely regretted this miscalculation, but could find no way to help it. And the dinosaurs, alas! had to be left behind. But the mammoth and the mastodon, and the dinotherium, the palaeotherium, and the anoptherium, and the pterodactyl, and the archaeopteryx, — and a host of other strange beasts and birds with long Latin names, — refused to go in at all, in spite of Noah's warnings.

All these of course were doomed to be lost, and become fossils to be put in museums with stones and labels.

VARIOUS EXPERIENCES OF ANIMALS DURING THE FLOOD

Modern lore has added a number of incidents to the Biblical account of the days upon the water. It is said that, because of its incessant chattering, the magpie was compelled to perch outside upon the roof.[54] It is also stated that the magpie is unlucky because it preferred to perch outside and jabber over the submerged world.[55]

Jewish legend adds the following items:

One animal, the reëm, Noah could not take into the ark. On account of its huge size it could not find room therein. Noah therefore tied it to the ark, and it ran on behind. Also, he could not make space for the giant Og, the king of Bashan. He sat on top of the ark securely, and in this way escaped the flood of waters. Noah doled out his food to him daily, through a hole, because Og had promised that he and his descendants would serve him as slaves in perpetuity.[56]

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[53] Smith, E. Boyd, *The Story of Noah's Ark* (Houghton Mifflin Co., 1911).

[54] Ingersoll, E., *Birds in Legend, Fable and Folklore* (Longmans, Green and Co., New York, 1923), p. 102.

[55] Henderson, as cited in note 48.

[56] Ginzberg, as cited in note 2, 1 : 160.

English folklore contributes an interesting aetiological tale: [57]

> In the days of the flood the Ark sprung a small leak, and Noah, who had forgotten to bring carpenter's tools on board with him, was at his wit's end how to act. His faithful dog had followed him to the place where the leak was, and stood watching the influx of water. In his trouble Noah seized the dog and crammed his nose into the leak. This stopped it, but in a few moments Noah perceived that the dog must die if kept in this position any longer. By this time Noah's wife had come up and was standing by his side watching what was taking place. Noah thereupon released the dog, and taking his wife's arm stuffed her elbow into the crack. The danger was thus averted, but a dog's nose and a woman's elbow will remain cold as long as the world lasts.

How did so many animals that were hostile to man and to one another manage to live together in the ark? All animals were created harmless, and they became harmful only to punish man for his sins and to test his character.[58] God could have made them harmless again, just as Cybele tamed lions [59] or even as Orpheus pacified fierce beasts,[60] but for a Greek or a Roman Church Father who knew of the scores of proverbial enmities between animals in classical literature, it was easier to conceive of another solution, namely, barriers. This is what Origen did. He thinks that the rooms of Genesis vi. 14 were intended to keep the fierce and the tame animals apart.[61] It is noteworthy that the wild animals which Deucalion saved in his boat did him no harm.[62]

PROVISIONS

The divine directions for provisions are given in Genesis vi. 21: "And take thou unto thee of all food that is eaten, and thou shalt gather it to thee; and it shall be for food for thee, and for them."

These instructions, too, caused trouble for persons of an inquisitive disposition. In the first place, storage had to be provided

[57] Wright, E. M., *Rustic Speech and Folk-Lore* (Oxford University Press, 1913), p. 227, quoting from Lowsley, B. A., *Berkshire Words and Phrases*.

[58] See, for example, St. Augustine, *De Genesi ad Literam* 3.15 (*P. L.*, 34.289: cf. 290): Potuerunt ergo ista [animalia] etiam creata nihil nocere, si causa non exstitisset vel terrendorum puniendorumque vitiorum vel probandae perficiendaeque virtutis. Numerous references to similar material are given by Robbins, F. E., *The Hexaemeral Literature: A Study of the Greek and Latin Commentaries on Genesis* (University of Chicago Press, Chicago, 1912), p. 5, note 4.

[59] Ovid, *Fasti* 4.215–218.

[60] See, for example, Horace, *Carmina* 3.11.13; *Greek Anthology* 7.8.

[61] *In Genesim Homilia II* 1 (*P. G.*, 12.161).

[62] Lucian, *De Dea Syria* 13.

for food sufficient to last both man and beast about a year, a big problem in itself. To make matters worse, there were the different tastes of the animals, some of which were carnivorous. To keep flesh-eating animals alive, reasons Origen,[63] victims must have been introduced into the ark in addition to the quota necessary for the preservation of the species.

An alternative suggestion is made by St. Augustine.[64] The carnivorous animals may have forgone their special tastes during their stay in the ark and have eaten of a common mess. What is there which hunger does not drive one to eat? Still another explanation is that it was in God's power to enable the animals to survive without food.

A theory about the food supply is recorded by Bede,[65] who is not disinclined to subscribe to it. The suggestion was made that Noah provided enough food to last for one day, and that this was divinely replenished day by day — like the widow's cruse of oil. This miracle symbolizes the daily revivifying with the food of life of all those who are in the Church.

Bede himself holds that everything done in the ark reflects the miracles of divine power. He asks how the eight persons in it could have carried food and drink to all the animals. This raises the problem of drinking water, about which nothing was said to Noah in the instructions for building the ark. In addition, such a crew could not have kept conditions sanitary. Furthermore, if birds and beasts had remained in one place their limbs would have atrophied and they would have lost the power of locomotion. Such considerations lead Bede to ascribe to divine omniscience the sustenance and salvation of the animals. There is also the possibility that at the divine will the animals were lulled to sleep and remained quiescent until the day of exit.[66]

According to the flood story of Xisuthrus, provision was made for things to drink as well as to eat.[67] The version of the shiftless Negro is still more provident. In *The Green Pastures*, by Marc

[63] *In Genesim Homilia II* 1 (*P. G.*, 12.163).
[64] *De Civitate Dei* 15.27 (*P. L.*, 41.476).
[65] *Hexaemeron Liber II* (*P. L.*, 91.93).
[66] *Ibid.*
[67] Eusebius, *Chronica* 1.3.1 (*P. G.*, 19.113): ... congestisque illuc esculentis atque poculentis.

Connolly, Noah is afraid of the prospect of having to live with moccasins, "cotton-moufs," and rattlers, and hence wishes to take aboard "two kags of likker." [68]

In a Jewish tradition Shem thus speaks of the trouble experienced by the refugees aboard the ark in tending to the animals: "The day animals had to be fed by day, and the night animals by night. My father knew not what food to give to the little zikta. Once he cut a pomegranate in half, and a worm dropped out of the fruit, and was devoured by the zikta. Thenceforth my father would knead bran, and let it stand until it bred worms, which were fed to the animal." [69]

THE EXPLORATORY BIRDS

At the end of forty days Noah, wishing to find out whether the waters had receded, made use of birds (Genesis viii. 7–12):

And he sent forth a raven,[70] which went forth to and fro, until the waters dried up from off the earth.

Also he sent forth a dove from him, to see if the waters were abated from off the face of the ground.

But the dove found no rest for the sole of her foot, and she returned unto him into the ark; for the waters were on the face of the whole earth. Then he put forth his hand, and took her, and pulled her in unto him into the ark [see Plates II–III].

And he stayed yet other seven days, and again he sent forth the dove out of the ark.

And the dove came in to him in the evening, and, lo, in her mouth was an olive leaf plucked off: so Noah knew that the waters were abated from off the earth.

And he stayed yet other seven days, and sent forth the dove, which returned not again unto him any more.

In the Babylonian flood story [71] there are three birds:

When the seventh day approached,
I sent forth a dove and let her go.

[68] Pp. 70–71 (Farrar & Rinehart, New York, 1929).

[69] Ginzberg, as cited in note 2, 1 : 161.

[70] St. Ambrose, *De Noe et Arca Liber Unus* 17.63 (*P. L.*, 14:390), gives Roman reasons for the selection of the raven. He says that it is a prophet of future events and that its flight and cries are noted.

[71] Rogers, R. W., *Cuneiform Parallels to the Old Testament* (Eaton & Mains, New York, 1912), pp. 97–98.

The dove flew away and came back,
For there was no resting place and she returned.
I sent forth a swallow and let her go,
The swallow flew away and came back,
For there was no resting place, and she returned.
I sent forth a raven and let her go,
The raven flew away, she saw the abatement of the waters,
She drew near, she waded, she croaked (?) and came not back.
Then I sent everything forth to the four quarters of the heaven, I offered sacrifice,
I made a libation upon the mountain peak.[72]

The raven has always had an evil reputation. The doctrine of original sin is far more appropriate to it than to man. Philo-Judaeus [73] says that it typifies wickedness and that it is an insolent, unsociable bird. St. Ambrose pictures it as innately wicked [74] and the dove as naturally virtuous. These two birds are patterns of evil and virtue.[75]

Bede [76] regards the failure of the raven to return as symbolizing the sinner who refuses to return to the kingdom of God, or even the Devil. In an extended allegorical interpretation of the flood Bede [77] explains that the raven, by not coming back to the ark which had sheltered it, became a prophetic symbol of Simon, who, though baptized, was driven from the Church before he had received the favor of the Holy Spirit by the laying on of hands. Filled with the gall of bitterness Simon carried in his heart the blackness of the raven rather than the innocence and simplicity of the dove, which was popularly supposed to have no gall.[78]

[72] For references to the sending out of birds by Xisuthrus see Eusebius, *Chronica* 1.3 (*P. G.*, 19.115); Cyril, *Contra Julianum Liber I* (*P. G.*, 76.516).

[73] *Quaestiones et Solutiones in Genesin* 2.38 (cf. 35).

[74] *De Noe et Arca Liber Unus* 17.62 (*P. L.*, 14.391): Denique egressus corvus non revertitur ad iustum; quia fugitans omnis culpa est aequitatis, nec probitati videtur et iustitiae convenire.

[75] *Op. cit.*, 17–18 (*P. L.*, 14.391–392).

[76] *In Pentateuchum Commentarii, Genesis* 5–8 (*P. L.*, 91.226): Corvus dimissus et non reversus, figuram peccatoris vel diaboli tenet, ad regnum Dei non revertentis. See also Hilarius, *Tractatus in CXLVI Psalmum* (*P. L.*, 9.874): Corvum in formam peccatoris constitutum esse tum cum ex arca emissus non rediit, meminimus.

[77] *Hexaemeron Liber II* (*P. L.*, 91.101).

[78] Tertullian, *Liber de Baptismo* 8 (*P. L.*, 1.1317): . . . quod etiam corporaliter ipso felle careat columba. For other references see Thompson, D. W., *A Glossary of Greek Birds* (Oxford, The Clarendon Press, 1895), p. 140.

It is a remarkable thing that in many parts of the world white is postulated as the original color of the raven and the crow.[79] In order to account for their blackness various tribes and peoples tell of some misadventure with soot, a pot of paint, a bottle of ink, or tar. In some tales the blackness is due to punishment for black deeds. A Rumanian legend recounts how, as the waters of the deluge were subsiding, Noah sent out a raven to investigate, but it spent three days and nights glutting itself upon the carcass of a horse. On its return Noah cursed it: "'Thy feathers shall be like my heart!' And since Noah's heart was black [from anger], the raven's feathers changed their color forthwith and became black."[80]

In this story the raven incurred divine displeasure by feasting upon carrion. There are other tales, with different settings, which relate that the blackness of the raven is a punishment for its eating of corpses, but I was greatly surprised to find in Bede[81] a statement that the failure of the raven to return to the ark was due either to its being prevented by the waters or to its having alighted upon a floating corpse. Here we have an ideal setting for an aetiological story to explain how the raven became black. Obviously Bede knows nothing of a change in color. It would seem that the antediluvian raven became white at a considerably later date than Bede's.

A medieval Arab chronicle (of Abu Djafar Tabari) tells the story of the raven's feasting upon a corpse and God's cursing it, but it uses the incident to account for the raven's fondness for carrion, not for its change of color.[82]

In the Church Fathers no animal is more extolled than the dove.

[79] See McCartney, E. S., "Folk Tales Which Account for the Blackness of the Raven and the Crow," *Pap. Mich. Acad. Sci., Arts and Letters*, 12 (1930): 137–148.

[80] *Revue des traditions populaires*, 9 (1894): 620.

[81] *In Pentateuchum Commentarii, Genesis* 5–8 (*P. L.*, 91.223): Quod autem de corvo dicitur, quod non est reversus ad Noe, aut aquis utique interemptus est aut alicui mortuo cadaveri supernatanti iniectus, significat homines in immunditia cupiditatis teterrimos, ad illa quae foris sunt in hoc mundo intentos. St. Ambrose, *De Noe et Arca Liber Unus* 17 (*P. L.*, 14. 391), notes the raven's fondness for carrion: Siquidem omnis impudentia atque culpa tenebrosa est et mortuis pascitur, sicut corvus.

[82] Ingersoll, Ernest, as cited in note 54, p. 100. See also Ginzberg, as cited in note 2, 1: 164.

Perhaps none is mentioned more frequently. It is a paragon of Christian virtues, being simple, joyful, loving, and faithful [83] (see p. 93).

In Greek stories of the flood I find but one reference to a bird. Plutarch [84] tells us that Deucalion, too, sent forth a dove. According to the mythographers whom he quotes, its return was a sign of the continuation of bad weather and its flying away meant clear weather. The attribution of the dove to the vessel of Deucalion is supposed to have been due to Semitic influence.[85]

Modern lore attributes another weather scout to the ark. According to French lore, Noah sent the kingfisher out after the dove had gone. When a great wind sprang up it flew higher and higher in order to escape the waves. As it reached the blue firmament its gray color changed to blue. On descending it came too near the sun and the feathers on the lower part of its body began to redden and burn. It hastened down to the water to put out the flames, but after doing so it could nowhere find the ark, since Noah had used it to build a house and barn. One may still see the kingfisher, with anguished cry, searching along streams for Noah's ark or some trace of it. The bird even now has the blue color it acquired in the firmament and the reddish breast imparted by the heat of the sun.[86]

THE LANDING

The Biblical story says (Genesis viii. 4) that when the waters of the flood subsided the ark finally came to rest "upon the mountains of Ararat" [87] (see Pl. IV), but not all writers have allowed

[83] An elaborate picture of its many good qualities is drawn by Cyprian, *Liber de Unitate Ecclesiae* 9 (*P. L.*, 4.522): Simplex animal et laetum, non felle amarum, non morsibus saevum, non unguium laceratione violentum, hospitia humana diligere, unius domus consortium nosse; cum generant, simul filios edere; cum commeant, volatibus invicem cohaerere, communi conversatione vitam suam degere, oris osculo concordiam pacis agnoscere, legem circa omnia unanimitatis implere. Haec est in Ecclesia noscenda simplicitas, haec charitas obtinenda ut columbas dilectio fraternitatis imitetur. See also Clemens Alexandrinus, *Paedagogi Liber I* 5 (*P. G.*, 8.265).

[84] *Moralia* 968 F.

[85] Usener, as cited in note 20, p. 254.

[86] Sébillot, Paul, as cited in note 1, 3: 159.

[87] Isidore, *Etymologiae* 14.8.5, is a little more specific than the Bible. He says: Ararat mons Armeniae in quo arcam historici post diluvium sedisse

it to remain there. One ancient source [88] says that it was carried not to the mountains of Armenia, but to the mountains of Taurus, which overlooked the fields of Ararat. Julius Africanus [89] puts it among the mountains of Ararat, which he knows is in Parthia, but he is aware that others assign it to Celaenae in Black Phrygia.

The *Sibylline Oracles* [90] state that the ark came to rest on a mountain at the headwaters of the Marsyas. This legend is to be associated with the tradition of the flood as recorded on the coins of Apameia.[91]

I am informed by a friend that an Armenian tradition assigns the resting place of the ark to Mount Sipan near Lake Van and that a Mesopotamian legend locates it upon Nebel Judi, overlooking the plain of Mesopotamia.[92] The tribes of Assyrians, Arabs, Kurds, Yezides, and other races who live around Nebel Judi used to be continually at war, but at the feast of Noah they gathered on the mount to offer sacrifice.

It is a striking coincidence that the craft of Deucalion likewise settled down for the last time in several places: on Mount Parnassus in Boeotia;[93] on Mount Othrys in Thessaly;[94] on Mount Athos on the Chalcidian Peninsula;[95] and, finally, on Mount Etna

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testantur. See also 5.39.4; 14.3.35. In *The Travels of Marco Polo the Venetian*, Book I, Chapter IV, it is stated that the ark of Noah rested upon an exceedingly high mountain in the central part of Armenia.

[88] Hieronymus, *In Isaiam Prophetam* 11.38 (*P. L.*, 24.389).

[89] As quoted by Georgius Syncellus, *Chronographia*, *Corpus Scriptorum Historiae Byzantinae*, 12 : 38 (*P. G.*, 10.68).

[90] 1.261–267. A rather interesting version of the flood is contained in lines 128–282.

[91] See page 73 and also Ramsay, W. M., "The Legend of the Flood in Apameia," *The Cities and Bishoprics of Phrygia* (Oxford, The Clarendon Press, 1895, 1897), Part II: 669–672; Babelon, E., "La Tradition phrygienne du deluge," *Revue de l'histoire des religions*, 23 (1891) : 174–183. For other shiftings of the site at which the ark came to rest see Hastings and Selbie, *Dictionary of the Bible*, 1 : 140, *s.v.* "Ararat."

[92] The same informant tells me of an Armenian tradition according to which the starting point of the ark was a village north of Lake Sevang.

[93] Pindar, *Olympiaca* 9.64–67; Ovid, *Metamorphoses* 1.316–319; Apollodorus, *Bibliotheca* 1.7.2.

[94] Hellanicus, as quoted by the scholiast on Pindar, *Olympiaca* 9.62.

[95] Servius on Vergil, *Eclogae* 6.41.

in Sicily.[96] One is reminded of the rivalry of the seven cities in claiming to have been the birthplace of Homer.

According to a Jewish legend Noah was afraid to set foot upon the land even after the ark had come to rest:

> Though the earth assumed its old form at the end of the year of punishment, Noah did not abandon the ark until he received the command of God to leave it. He said to himself, "As I entered the ark at the bidding of God, so I will leave it only at His bidding." Yet, when God bade Noah go out of the ark, he refused, because he feared that after he had lived upon the dry land for some time, and begotten children, God would bring another flood. He therefore would not leave the ark until God swore he would never visit the earth with a flood again.[97]

If we may trust Julius Africanus,[98] the animals issued from the ark not in the order in which they had entered it, but male and female of each species together, just as they happened to encounter each other.

After landing Noah "builded an altar unto the Lord; and took of every clean beast, and of every clean fowl, and offered burnt offerings on the altar" (Genesis viii. 20). In similar manner Deucalion, after floating about in the flood for nine days and nine nights, made sacrifice.[99]

The site upon which Noah disembarked was called in antiquity Ἀποβατήριον, "Place of Descent."[100] The name of a modern Armenian village, Nakhichevan, "The First Place of Landing," commemorates the same event.[101]

RELICS

According to classical tradition, parts of the ark were sought for their supposed curative and magical properties (see p. 91). Frag-

[96] Hyginus, *Fabulae* 153. Deucalion and his wife were not, however, the sole survivors of this flood. A certain Megarus escaped by following the cries of cranes (*geranoi*) to a mountain of Megara later called Gerania in memory of this event. See Pausanias 1.40.1; *Etymologicon Magnum*, p. 228, *s.v.* Γεράνεια.

[97] Ginzberg, as cited in note 2, 1 : 164–165.

[98] As quoted by Georgius Syncellus, *Chronographia*, *Corpus Scriptorum Historiae Byzantinae*, 12 : 39 (*P. G.*, 10.68).

[99] Apollodorus, *Bibliotheca* 1.7.2.

[100] Josephus, *Antiquitates Iudaeorum* 1.3.5.

[101] Boettiger, Louis A., "Armenian Legends and Festivals," *Research Publications of the University of Minnesota, Studies in the Social Sciences*, No. 14, p. 41.

ments of the ark and even hairs from Noah's beard were among the countless relics venerated in churches during the Middle Ages.[102] According to a fourteenth-century writer,[103] even as late as the time of Constantine the Romans had possession of the axe with which Noah built the most famous boat in history. The emperor buried it, along with a number of other sacred relics, beneath a porphyry column which he had transported from Rome to Constantinople. I am informed by an archaeologist that Noah's Bible is still shown in a church at Nakhichevan.

Noah himself was somewhat of an antiquarian. He is said to have preserved in the ark a book in which Enoch predicted the deluge. It was the first of three hundred volumes which Enoch composed with knowledge acquired from long residence among the angels.[104]

Another legend informs us that from Adam the Stone of Foundation descended to Seth. From Seth it passed by regular succession to Noah, who took it with him into the ark, and after the subsidence of the deluge made on it his first thank-offering. Noah left it on Mount Ararat, where it was subsequently found by Abraham, who removed and constantly used it as an altar of sacrifice.[105]

ARMENIAN TRADITIONS

Throughout the ages until today Armenia has been a rich vineyard of lore about the flood,[106] or about floods which were associated with the Biblical deluge by pagan writers. I am told by an Oriental scholar and by a medical missionary that the animals of the ark are represented on a frieze which decorates the outside of an ancient church on the island of Akhtamar in Lake Van (see Pl. V). The Armenian tradition holds that Noah founded Nakhichevan and claims that a mound of earth in the city is his grave.[107] Moslems, however, have held in equal veneration a tomb of Noah in the Holy Land, in Anti-Lebanon on a side of the vale

[102] Hastings, as cited in note 13, 10 : 655.

[103] Nicephorus Callistus, *Ecclesisastica Historia* 7.49 (*P. G.*, 145.1326).

[104] Conway, M. D., *The Wandering Jew* (Henry Holt and Co., New York, 1881), pp. 56–67.

[105] Mackey, Albert G., *An Encyclopaedia of Freemasonry and Its Kindred Sciences* (Moss & Co., Phila., 1874), p. 752.

[106] See Boettiger, as cited in note 101, pp. 39–43.

[107] *Encyclopaedia Britannica*, Eleventh edition, 19 : 156.

of Coele-Syria.[108] It will be recalled that Zeus, too, had more than one grave.

Remains of the ark were shown by Armenians in the days of Josephus [109] and even till the time of St. Chrysostom.[110] There were likewise preserved for a long while timbers of an ark which reached a mountain called Baris, upon which many people had sought refuge above the waters.[111]

In folklore, things from a distance and things unique or rare have peculiar powers attributed to them by popular imagination, whether for good or for ill. When Noah's ark landed in Armenia it fulfilled both these conditions, and to it and its parts magical virtues were ascribed. Berosus [112] said that in his day there was still part of the ship in the mountains of the Cordyaeans and that people carried off pieces of pitch to be used as a protection against evil. In an account of a flood by Abydenus a boat is driven to Armenia and people make amulets of the wood and wear them about their necks.[113] There is a similar statement about the boat of Xisuthrus.[114]

A piece of wood supposed to have come from the ark is still preserved "in an ancient Armenian church in the tiny village of Echmiazin on the borders of Turkey and Armenia." It is "a slab of petrified wood about the size of an octavo book." The bishop of the church tells "a legend that the angels deposited it in the church in the fourth century, taking pity on the monks, many of whom had lost their lives seeking to scale Mount Ararat." [115]

[108] Stanley, A. P., *Sinai and Palestine*, New edition (John Murray, London, 1875), p. 408.

[109] *Antiquitates Iudaeorum* 1.3.5.

[110] *De Perfecta Caritate* 7 (*P. G.*, 56.288).

[111] Josephus, *Antiquitates Iudaeorum* 1.3.6.

[112] See Josephus, *Antiquitates Iudaeorum* 1.3.6. See also Eusebius, *Chronica* 1.3.3 (*P. G.*, 19.166); *idem*, *Praeparatio Evangelica* 9.11 (*P. G.*, 21.697).

[113] Eusebius, *Praeparatio Evangelica* 9.12 (*P. G.*, 21.699). See also Eusebius, *Chronica* 1.3.3 (*P. G.*, 19.116).

[114] Cyril, *Contra Julianum Liber I* (*P. G.*, 76.516). French lore seems equally specific. See Sébillot, as cited in note 1, 1 : 392: "Près de Saales, en Alsace-Lorraine, on fait voir l'empreinte de l'arche de Noé sur des blocs granitiques."

[115] An Associated Press dispatch of August 18, 1932, as published in the Philadelphia *Public Ledger* of August 19, 1932. The slab was discovered by Carveth Wells, explorer and lecturer, who took moving pictures of it.

As early as 1254 [116] a legend was told to prove that the ark was still upon the sacred top of Mount Ararat and that its ascent was forbidden to mortal foot. In order to test the credibility of the Holy Scriptures a monk named Jacob tried to scale the mountain, but through fatigue he would fall asleep and on awakening would find himself at the point from which he had started. At length God had compassion upon him and sent an angel to tell him in his sleep that his goal was unattainable. That the monk might have some reward for his zeal God sent to him a piece of the ark.[117]

No one succeeded in reaching the summit of the mountain till 1829,[118] but the Armenian peasant is still loath to believe that anyone has accomplished this feat. With him it is an article of faith that the ark is still at the top, though not visible.[119]

The Christians of the time of St. Augustine thought they saw a ritual relic of the flood in the running to and fro between the heights and the plains in the ceremony of the Lupercalia. This part of the rites they regarded as representing the fleeing of people to the mountains as the water rose and their descent to the lowlands as it subsided.[120]

MYSTICISM AND ALLEGORY

I have already had occasion to give two or three examples of mysticism and allegory in the interpretation of the events of the flood, but scores of others might be added.[121] In fact, he would be

[116] See Bryce, Sir J., *Transcaucasia and Ararat* (Macmillan and Co., London, 1877), p. 204.

[117] Parrot, F., *Journey to Ararat*, translated by W. D. Cooley (Harper & Bros., New York, 1846), pp. 162–163. See also Boettiger, as cited in note 101, p. 41, where the story is told with some variations.

[118] See *Encyclopaedia Britannica*, Fourteenth edition, 2:214–215, *s.v.* "Ararat," where literature on Mount Ararat is also given. An interesting reference is Bryce, as cited in note 116, pp. 198–208.

[119] "E. C.," *Fraser's Magazine*, New Ser., 13 (1876):286.

[120] St. Augustine, *De Civitate Dei* 18.12 (*P. L.*, 41.569).

[121] Extended references are Origen, *In Genesim Homilia II* (*P. G.*, 12.162–175); Ambrosius, *De Noe et Arca Liber Unus* (*P. L.*, 14.368–397); St. Augustine, *De Civitate Dei* 15.26–27 (*P. L.*, 41.472–476); *idem*, *Contra Faustum Manichaeum*, 12.14 (*P. L.*, 42.262); Bede, *Hexaemeron Liber II* (*P. L.*, 91.85–103); *idem*, *In Pentateuchum Commentarii, Genesis* 5–8 (*P. L.*, 91.221–226); Philo-Judaeus, *Quaestiones et Solutiones in Genesin* 2.1–47.

a resourceful person who could find some detail of the story which has not suffered a figurative interpretation, or suffered from it.

We are told by St. Chrysostom [122] that the ark typified the Church, Noah Christ,[123] the dove the Holy Spirit, the leaf of the olive the kindness of Christ. It was by a quite natural process that the dove and the olive branch (Pl. VI) — or the branch alone — came to signify deliverance and peace.[124] The dove was likewise a symbol of baptism and of the peace granted to the soul after the tribulations of life on earth.[125]

In the First Epistle of St. Peter (iii. 20) the water of the flood is regarded as the symbol of baptism (see Pls. II–III). Tertullian [126] elaborates the picture of the ark as the symbol of the Church. Of a part of Genesis vii. 17, ". . . and the waters increased, and bare up the ark, and it was lifted above the earth," Bede [127] makes the following interpretation: "And the waters of baptism and faith, multiplied throughout the whole world, raised the Church from the yearning for earthly things to the hope and desire of a heavenly life; but as the waters of tribulation beat against the Church, the more violently they covered everything, so much higher they drove it to seek the joys of another life." When the ark came to rest upon the summit of the mountains of Ararat it was figuratively trampling under foot the acme of earthly pomp and approaching the joys of heaven.[128]

The cataract from the heavens signifies the pouring forth of the evangelic and apostolic preaching which manifestly waters human hearts from above.[129] Since the number forty is composed of ten

[122] *De Lazaro Concio VI* (*P. G.*, 48.1037): cf. the same author's *In S. Phocam Martyrem* (*P. G.*, 50.702).

[123] Cyprian, *Epistola* 63.3 (*P. L.*, 4.386–387) says that the drunken Noah was the symbol of the passion of Christ.

[124] See Lowrie, W., *Monuments of the Early Church* (The Macmillan Co., New York, 1906), p. 206.

[125] Marucchi, O., *Manuale di archeologia cristiana* (Desclée & C., Rome, 1908), p. 336. See also pp. 316–318.

[126] *Liber de Baptismo*, Caput VIII (*P. L.*, 1.1317).

[127] *Hexaemeron Liber II* (*P. L.*, 91.97).

[128] *Ibid.* (*P. L.*, 91.99): Requievit autem super montes Armeniae quia calcato apice pompae mundialis, etiam in hac peregrinatione vitam ducens, coelestibus gaudiis animo propinquat.

[129] Bede, *Hexaemeron Liber II* (*P. L.*, 91.96): Cataractae autem coeli

taken four times, the rain of forty days and forty nights represents the ten commandments in the four quarters of the earth. Hence everyone everywhere may be cleansed by the rite of baptism from above.[130]

If ratios mean anything the world must have been very sinful in Noah's day to require a baptismal ceremony of forty days and forty nights. It took only a nine days' flood for Zeus to cleanse the world in the days of Deucalion and Pyrrha.[131]

The presence of clean and unclean animals in the ark typifies conditions in the Church, for not all those who undergo the rite of baptism preserve the purity of good works.[132] The raven and the kite and the wolf and the dog and the serpent all have their counterparts in the Church, but no animal in the ark symbolizes an idolator for the simple reason that there is no idolator in the Church.[133]

Cyprian [134] thought that a person outside the Church had no more chance of salvation than one of the victims of the deluge. The great perfection of those who enter the Church and through faith and deeds worthy of their faith attain to eternal joys is symbolized by the great age of Noah, six hundred years.[135]

Even the pitch which was used both within and without the ark has a symbolic meaning, for it signifies the safety of the Church from the leaking in of heresy.[136]

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effusionem evangelicae et apostolicae praedicationis quae manifeste de supernis terrena corda inrigant designant.

[130] Bede, *Hexaemeron Liber II* (*P. L.*, 91.96–97).

[131] Apollodorus, *Bibliotheca* 1.7.2.

[132] Bede, *Hexaemeron Liber II* (*P. L.*, 91.93–94).

[133] Tertullian, *De Idololatria* 24 (*P. L.*, 1.774).

[134] *Liber de Unitate Ecclesiae* (*P. L.*, 4.519): Si potuit evadere quisquam qui extra arcam Noe fuit, et qui extra ecclesiam fuerit evadit. Cf. Bede, *Hexaemeron Liber II* (*P. L.*, 91.91): qui ab Ecclesia vel fide vel opere vel utroque separati pereunt.

[135] Bede, *Hexaemeron Liber II* (*P. L.*, 91.94): Aetas Noe magnam eorum qui ecclesiam ingrediuntur et per fidem atque actionem fide condignam ad aeterna gaudia perveniunt, perfectionem designat.

[136] *Ibid.* (*P. L.*, 91.87–88): Bitumen est ferventissimum et violentissimum gluten, cuius haec virtus est ut ligna quae ex eo fuerint lita nec vermibus exedi nec solis ardore vel ventorum flatibus vel aquarum possint inundatione dissolvi; unde quid aliud mystice in bitumine quam constantia fidei accipitur? Bituminatur autem arca intrinsecus et extrinsecus et sic universe perficitur dum et cogitationes electorum et opera, ne ullis vincantur aut decipiantur

The symbolism of St. Augustine [137] is interesting. The ark is without doubt a representation of the city of God, i.e. the Church, which is wandering about and which is made secure by the wood on which was suspended Jesus Christ, the mediator between God and man.

The proportions of the ark were the same as those of the human body, which for the sake of convenience of comparison he regards as either supine or prone upon the ground. The length is precisely six times its breadth and ten times its height. Perhaps the association with the human body was suggested by the classical canons of proportion of the human body.[138]

The opening or window in the side of the ark is the wound made by the spear in the body of Christ at the crucifixion.

The three stories of the ark are the three sons of Noah. They are also to be regarded as Faith, Hope, and Charity.

Such are but a handful of the examples of symbolism drawn by the Christian Fathers from the Biblical account of the flood. They might be extended, but, as St. Augustine says,[139] it would be a long story.

FOSSILS AND THE FLOOD

Of the height to which the forty days' rain caused the waters to rise the Bible says (Genesis vii. 19–20):

> And the waters prevailed exceedingly upon the earth; and all the high hills, that were under the whole heaven, were covered.
>
> Fifteen cubits upward did the waters prevail; and the mountains were covered.

As convincing testimony of the reality of Noah's flood the Christians used the fossils which were found in the interior and on mountains. Eusebius [140] says that he confirmed with his own eyes

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vitiorum incursibus, fidei in omnibus muniuntur. An equally interesting reference is St. Augustine, *Contra Faustum Manichaeum* 12.14 (*P. L.*, 42.262).

[137] *De Civitate Dei* 15.26 (*P. L.*, 41.472).

[138] Vitruvius, 3.1.3, gives some measurements of a man placed flat upon his back.

[139] *Ibid.* (*P. L.*, 41.473): . . . sed ea nunc persequi longum est.

[140] *Chronica* 1.16.12 (*P. G.*, 19.153–154). Cf. Cedrenus, *Historiarum Compendium, Corpus Scriptorum Historiae Byzantinae*, 35 : 27: cf. Tertullian, *De Pallio* 2 (*P. L.*, 2.1088).

the truth of the statement that the deluge exceeded the height of the highest mountains. When building stones were taken from the highest quarries on Mount Lebanon there were found in a perfect state of preservation fossils of various species of sea fish as large as hats. He adds that persons who hear of these things interpret them each one according to his own pleasure. He is evidently referring to pagans who used fossils as proof of the flood of Deucalion. Isidore,[141] too, is sure of the truth of the Biblical story because of the shells which, though found amid mountains remote from the sea, nevertheless show the effects of the action of water.[142]

In discussing the significance of "a remarkable bed of marl, containing a thin layer of tertiary shells, extending over a considerable space of ground" in the vicinity of Mount Ararat a modern writer says:[143]

> Since, then, we have the evidence of Scripture that the ark rested on Mount Ararat, and consequently that this portion of the earth was flooded by the Deluge, which occurred at the time of Noah, and as there is no reason to suppose that these elevated plains have ever been subsequently flooded, it does not seem presumptuous to imagine that this shell-bed was the result of the Noachic Deluge, and was deposited during the period when the accumulated waters remained in this portion of the world.

It has not been many decades since learned men have ceased to regard shells and fossils as proof of the flood.[144] In speaking of the early history of the United States J. B. McMaster says:[145] "So little was known of geology that the drift and erratic bowlders of the Glacial Age were cited in the sermons of the time as evidence of the flood so conclusive as to silence all doubters."

In Biblical matters the uneducated have often reasoned in the same way, as we may see from the following quotation:

[141] *Etymologiae* 13.22.2.

[142] It is of interest to note that other nations have used fossils and shells as proof of a flood. See Frazer, *Folk-Lore in the Old Testament* (Macmillan and Co., London, 1919), 1 : 217, 222, 245, 328, 338, ff.

[143] Hamilton, W. J., *Researches in Asia Minor, Pontus, and Armenia* (John Murray, London, 1842), 2 : 387.

[144] White, as cited in note 49, 1 : 236: cf. 1 : 225–239.

[145] *A History of the People of the United States from the Revolution to the Civil War* (D. Appleton and Co., New York, 1900), 1 : 25.

The Cornish tynners hold a strong imagination, that in the withdrawing of Noah's floud to the sea the same took his course from east to west, violently breaking vp, and forcibly carrying with it the earth, trees, and rocks, which lay anything loosely neere the vpper face of the ground. To confirme the likli-hood of wich supposed truth, they doe many times digge vp whole and huge timber-trees, which they conceiue at that deluge to haue been overturned and whelmed.[146]

We are told in Genesis vi. 4 that there were giants on the earth in the days before the flood. In the *City of God* [147] St. Augustine used the evidence of fossil bones to prove that men were larger before the flood: "But with regard to great size of body skeptics are very often convinced by the exposure, through lapse of time or the violence of streams or by various chances, of tombs in which incredibly large bones of the dead have come to light or from which they have fallen out. Not only I myself but several men with me on the shore of Utica saw a molar so large that if it were cut up into small teeth the size of ours it seemed it could have made a hundred. But that, I believe, belonged to some giant."

In our own country in the year 1784 "So little was understood of palaeontology that the bones of a mastodon dug up at Claverack, on the Hudson, seventy-two years before, were still believed to be those of a giant." [148]

THE DISSEMINATION OF SPECIES

Exploration and travel brought even greater trouble for the literal interpretation of the story of the flood. Frogs might be found anywhere, since they sprang from the earth, but what about wolves and other animals which must have parents? How did they come to be found on islands if they were not descended from any animals except those preserved in the ark? Some of the islands could have been reached by swimming, but only the nearest ones. Some are so far from continents that no beast could reach them. Perhaps man transported the animals. But if they sprang from the earth, as at the original creation, and if the earth brought forth animals on islands which they could not reach, then it becomes

[146] Courtney, M. A., *Cornish Feasts and Folk-Lore* (Beare and Son, Penzance, 1890), p. 132. The quotation is given here at second hand.

[147] 15.9 (*P. L.*, 41.448).

[148] McMaster, as cited in note 145.

clear that all kinds of beasts were in the ark not so much for the sake of re-creating their kind as to symbolize the various nations in the sacrament of the Church.[149]

One of the most potent forces in breaking down the old theories was the discovery of America. In 1590 Joseph Acosta said in his *Natural and Moral History of the Indies:* [150]

> Who can imagine that in so long a voyage men woulde take the paines to carrie Foxes to Peru, especially that kinde they call "Acias," which is the filthiest I have seene? Who woulde likewise say that they have carried Tygers and Lyons? Truly it were a thing worthy the laughing at to thinke so. It was sufficient, yea, very much, for men driven against their willes by the tempest, in so long and unknowne a voyage, to escape with their owne lives, without busying themselves to carrie Woolves and Foxes, and to nourish them at sea.

Another writer asked how the sloth could have acquired energy enough to travel from Ararat to South America.[151] It was also incumbent upon theologians to explain how the kangaroo reached Australia and why it is found nowhere else.[152]

OTHER FLOODS

As we have seen incidentally, there were several heterodox floods in antiquity, but attempts were made to identify them with the Biblical deluge. Thus Cyril,[153] in discussing an Assyrian account of a flood, says that Noah was called Xisuthrus and that a second departure from truth was made in ascribing the prediction of the flood to Saturn instead of to the greatest deity.

Josephus [154] took it for granted that all the tales of flood which he found in various histories referred to the Biblical one. Eusebius [155] quotes Josephus with evident approval. Jerome [156] states that all who write pagan history have something to say of the ark and the flood.

[149] St. Augustine, *De Civitate Dei* 16.7 (*P. L.*, 41.485).

[150] White, as cited in note 49, 1 : 46. [151] *Ibid.* 1 : 48. [152] *Ibid.*

[153] *Contra Julianum Liber I* (*P. G.*, 76.516). See also Eusebius, *Chronica* 1.2.9 (*P. G.*, 19.114): . . . Xisuthrum eundem esse hominem qui ab Hebraeis Noachus vocatur.

[154] *Antiquitates Iudaeorum* 1.3.6.

[155] *Praeparatio Evangelica* 9.10 (end)–11 (*P. G.*, 21.698).

[156] *Liber de Situ et Nominibus Locorum Hebraicorum* (*P. L.*, 23.860).

For purposes of comparison the great flood of classical tradition is interesting, especially as it is described by Apollodorus: [157]

> . . . And when Zeus would destroy the men of the Bronze Age, Deucalion by the advice of Prometheus constructed a chest, and having stored it with provisions he embarked in it with Pyrrha. But Zeus by pouring heavy rain from heaven flooded the greater part of Greece, so that all men were destroyed, except a few who fled to the high mountains in the neighbourhood. It was then that the mountains in Thessaly parted, and that all the world outside the Isthmus and Peloponnesus was overwhelmed. But Deucalion, floating in the chest over the sea for nine days and as many nights, drifted to Parnassus, and there, when the rain ceased, he landed and sacrificed to Zeus, the god of Escape.

This flood, according to tradition, occurred in the sixty-seventh year after the birth of Moses.[158]

The flood of Deucalion ended when the waters sank through a cleft a cubit wide in the precinct of Olympian Earth within the sacred inclosure of Olympian Zeus at Athens. Every year the Athenians threw into the opening wheaten meal kneaded with honey.[159]

It seems hopeless to combat the idea of a universal deluge. The size of the flood has kept pace with widening geographical knowledge. It is a poverty-stricken area that does not boast of a flood of its own. Over two hundred and fifty pages have been devoted to traditions of floods by Sir James G. Frazer in *Folk-Lore in the Old Testament*.[160] Even Seneca, who so often thought the thoughts of the Hebrews, imagined that the final destruction of the world was going to be by a flood.[161]

The questions that kept the early Christian Fathers busy defending the story of the flood gathered strength and fury throughout the centuries.[162] If accumulating scientific facts put

[157] Apollodorus, *Bibliotheca* 1.7.2 (J. G. Frazer's translation in the Loeb Classical Library). Lucian, *De Dea Syria* 12–13, is interesting on the flood. See also Frazer, J. G., "Ancient Greek Stories of a Great Flood," *Folk-Lore in the Old Testament* (Macmillan and Co., London, 1919), 1 : 146–174.

[158] Cyril, *Contra Julianum Liber I* (*P. G.*, 76.518).

[159] Pausanias 1.18.7. On the ceremony of letting water down a hole in commemoration of the flood see Lucian, *De Dea Syria* 13.

[160] In Volume I.

[161] *Naturales Quaestiones* 3.27–29.

[162] As recently as 1834 a certain "Hermogenes" published an article called "Noah's Journal of the Ark," *Fraser's Magazine*, 9 (1834) : 288–289, in which he quoted verses from the Biblical account of the deluge and tried to give a serious, scientific evaluation of them.

new weapons in the hands of opponents, they merely made the defenders more resourceful and keener for the struggle. It has been only in the last few centuries that advocates of literalism have been forced by the mass of evidence to shift their ground on some points and to retire from their position on others. Many of the arguments pro and con have been marshaled in an interesting book by Andrew D. White, *A History of the Warfare of Science with Theology in Christendom.*[163]

There are still loud echoes of the contest. A few years ago (1929) a professor was reported to have lost his position because in a chapel address he told the students that there are more than six hundred thousand species of animals classified and several hundred thousand extinct or unclassified, and that the limited engineering knowledge of Noah's time would not permit the building of a boat capable of holding two of each species of animal.

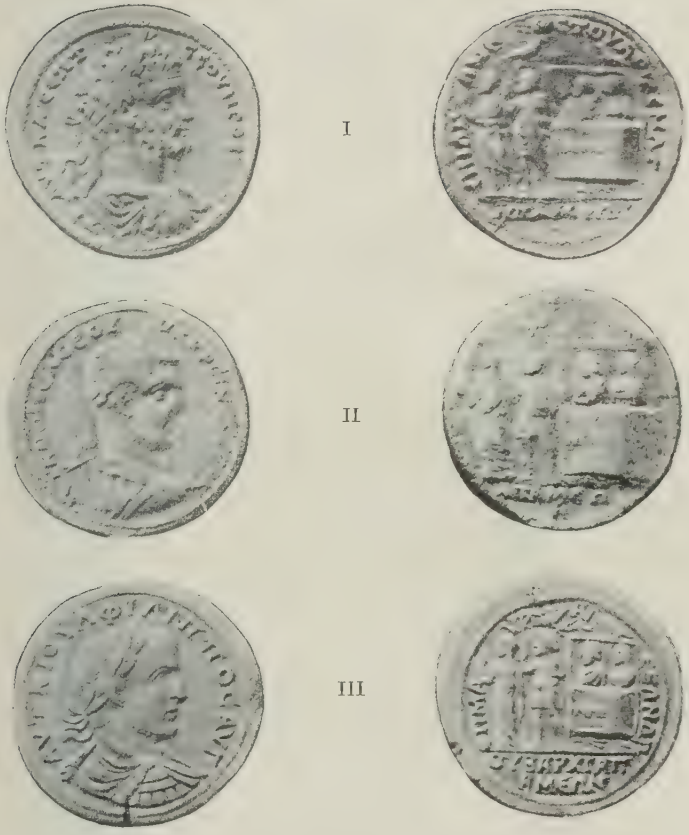
Examples of the conflict between literalism and liberalism are not infrequent in the writings of the Christian Fathers, but perhaps that of Noah and the flood is the most satisfactory for a study of this kind, since it would be hard to find another which has brought so many clashes with expanding scientific knowledge in different fields. The attitude which churches and people in general take toward the interpretation of Genesis continues, however, to be a reliable index of the religious and mental health of modern communities.[164]

University of Michigan

[163] D. Appleton and Co., New York, 1896.

[164] After this paper had been paged I found an additional interesting reference: S. Baring-Gould, *Legends of Old Testament Characters from the Talmud and Other Sources* (Macmillan and Co., London and New York, 1871), 1 : 116–142. Chapter XVIII (pp. 141–142), "Relics of the Ark," contains some curious information that is pertinent to pages 89–92 of this paper. Doubtless much similar lore is to be found in a work by Collin de Plancy, *Légendes de l'Ancien Testament* (Paris, 1861), which is not available at this time.

PLATE I



Coins of Apamea Kibotos, showing Noah and his wife seated in the ark and also with hands upraised in the attitude of devotion after having landed. The busts on the obverses of the coins are those of (I) Septimius Severus, (II) Macrinus, and (III) Philip I. Reproduced from *Proceedings of the Society of Biblical Archaeology*, 25 (1903), plate facing page 226

PLATE II

FIG. 1

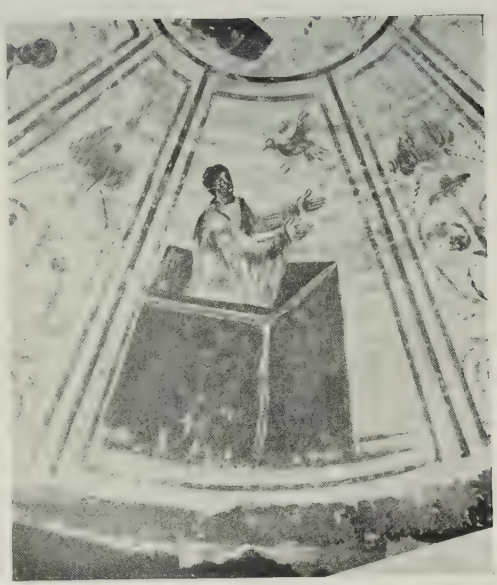


FIG. 2

Paintings from the catacomb of Domitilla, dated in the first half of the third century (Fig. 1) and the middle of the fourth (Fig. 2), showing Noah in a boxlike ark upon the waters of the deluge. Reproduced from J. Wilpert, *Die Malereien der Katakomben Roms*, Plates 56 and 196 (see note 30)

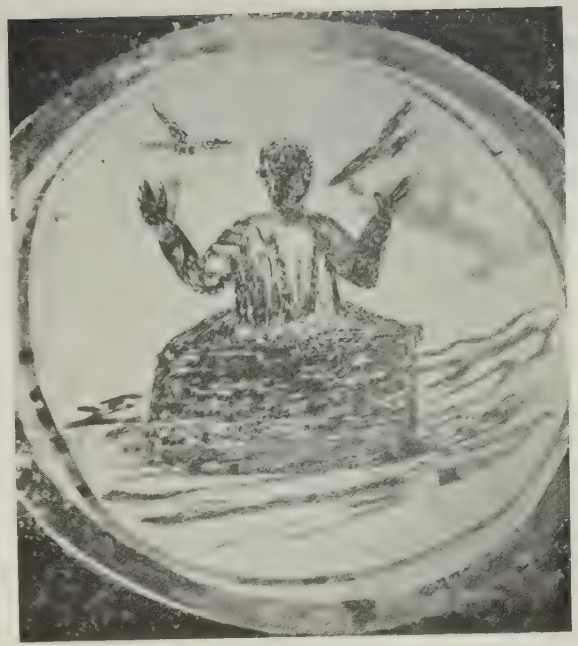


FIG. 1

FIG. 2

Paintings from the catacomb of Peter and Marcellinus, dated in the middle (Fig. 1) and second half (Fig. 2) of the fourth century, showing Noah in a boxlike ark upon the waters of the deluge. Reproduced from J. Wilpert, *Die Malereien der Katakomben Roms*, Plates 186 and 187

PLATE IV

THE TWIN PEAKS OF ARARAT

Reproduced, by permission of the publishers, from a volume by Mabel E. Elliott, *Beginning Again at Ararat* (Fleming H. Revell Co., New York, 1924), plate facing page 268

PLATE V

A tenth-century church on the island of Akhtamar in Lake Van. Among the reliefs of Biblical scenes on the outside is a frieze which shows the animals of the ark (see text, p. 90). The photograph was secured through the courtesy of the American Board of Commissioners for Foreign Missions, Boston, Massachusetts

PLATE VI

A fourth-century painting from the catacomb of Domitilla, showing a dove, the symbol of many Christian virtues (see text, pp. 86–87, 93). Reproduced from J. Wilpert, *Die Malereien der Katakomben Roms*, Plate 183

THE EXCAVATIONS AT SELEUCIA ON THE TIGRIS

ROBERT H. McDOWELL

THE city of Seleucia lay on the west bank of the Tigris River in lower Mesopotamia, some sixty miles north of Babylon. Our literary sources, largely Greek and Roman but to some extent Babylonian, Jewish, Syrian, and Arab, afford numerous though generally unsatisfactory glimpses of the life of Seleucia from the date of its founding, toward the close of the fourth century B.C., to a period early in the third century A.D., when all mention ceases. Modern writers and travelers have placed the site of the city at a complex of mounds lying on the west bank of the Tigris just opposite the ruins of Sassanian Ctesiphon, and some eighteen miles below the modern city of Baghdad.

In the fall of 1927 Professor Leroy Waterman of the University of Michigan undertook investigations south of Baghdad to determine the site of Opis, which, in its various phases, represents one of the oldest centers of Sumerian and Babylonian cultures. Regarding the site of the city there has been much dispute. Strabo [1] very definitely implies that Seleucia and Opis occupied the same site or adjoining ones. Xenophon,[2] on the other hand, in his account of the retreat of the Ten Thousand, places Opis some distance to the north. Reliable references to the location of Opis in the cuneiform texts, checked by topographical surveys and by photographs taken from the air, enabled Professor Waterman to determine definitely that the remains of Opis and Seleucia are represented by a single complex of mounds lying some two miles to the west of the present Tigris bed, on the west bank of an old river bed from which the Tigris diverged at an unknown date in the past. These conclusions were con-

[1] 16.1.9.

[2] *Anabasis* 2.24.5.

firmed by subsequent excavation and have received general recognition. The mounds previously thought to have represented Seleucia cover, in fact, the western quarters of Ctesiphon.

Under the direction of Professor Waterman excavations have been carried on at Seleucia every season from 1927–28 to 1931–32 through a joint expedition of the University of Michigan, the Toledo Museum of Art, and, for the last two seasons, the Cleveland Museum of Art. The complex of mounds today embraces an area of about five square miles. Originally they were larger, but at some period or periods since the desertion of the city changes in the Tigris River bed and flooding from the Euphrates have resulted in the washing away of portions of the mounds to an extent which has not as yet been determined. The mounds attain an average height of about twenty-five feet above the present level of the plain. This alluvial plain itself appears to have risen about the same distance during the past two and a half millennia. Ground water is invariably found from twenty-five to thirty feet below the surface of the plain. The lowest remains of occupation yet recovered within the area of the complex lie from seven to ten feet above this water. In order fully to excavate the complex down to water level it would be necessary to remove some two hundred million cubic yards of earth and débris. The maximum seasonal turnover of such materials, under conditions that insure the recovery and preservation of the remains, is approximately fifty thousand cubic yards.

The impossibility of completing the excavation of any considerable portion of the complex has rendered necessary a great amount of exploration in order to determine the areas in which material of the greatest value for study purposes may be obtained with the least duplication of results. Of prime importance in this regard has been a series of air photographs fitted together into a mosaic to include the whole complex. From a height of about six thousand feet the camera has been able to distinguish and record the principal features of the structure of the city, especially in the upper, or later, phases. These features, which for the most part are invisible to the naked eye, comprise the city walls, the system of streets and blocks and, to a certain

extent, the outline of monumental structures. The technique of the photography of subsurface objects from the air is, of course, in its infancy. On the mosaic large areas remain totally obscure, and in many instances we are unable to interpret the camera record. Numerous trial trenches have been dug at various points on the complex, and two principal vertical cuts on a large scale have been made from the surface of the mounds to water level. One of these cuts has been enlarged to include a whole city block, an area approximately 250 by 450 feet. Within this block excavation has been carried down uniformly to a point about two thirds of the distance from the surface to water level. Both vertical cuts have revealed between the surface and water level four distinct levels of architectural remains, each subdivided into two or more levels of occupation. The relation of the levels to one another indicates that they were not separated in time by long periods of disoccupation. The results of the investigation of two areas do not, of course, establish the facts for the complex.

The objects that have been recovered in the course of the excavations may be divided into two categories in respect to provenance, those from the surface of the mounds, and those from the various levels of architectural remains. On the surface are found, besides remains from the latest level of occupation, a surprisingly large proportion of objects from each of the lower levels. Their presence is due principally to the building operations of the inhabitants of each level, the sinking of foundations and wells. As a result of this process objects have been recovered that properly belong to levels now below water level, even the remains of the occupation of Opis prior to the foundation of the new city. The following list will illustrate the variety of objects that have been found, without regard to provenance. The totals given are exclusive of the results during the excavations in 1931–32. Fragmentary objects have been included, provided they have a value for the purposes of study. Pottery, nearly 2,000 pieces; terra cotta lamps, more than 2,000; glass objects, except beads, more than 100; beads of all kinds, more than 3,000; objects of gold, silver, and bronze, including ornaments, utensils, and figures, more than 650; utensils of bone and ivory, more than 300; fig-

ures of the same materials, more than 150; terra cotta figurines, nearly 3,000; statuettes and fragments of statues made of stone, plaster, or alabaster, 77 pieces. The quantity of coins that have been recovered is so large that it has not been practicable to count them; they amount to many thousands. Written material recovered is in large measure Greek, but includes cuneiform Babylonian, Aramaic, Pehlevi, Syriac, Cufic, and Arabic. The Cufic and Arabic are representative of a late occupation of the mounds after Seleucia was in ruins.

The study of the material results of the excavations is proceeding under the direction of the Institute for Archaeological Research of the University of Michigan. Pending the completion of these studies it is, of course, impossible to formulate an adequate analysis of the significance that may be attached to the results. Some facts have already been established, and many trends discerned that are of interest to the student of the Hellenistic East. It is especially important to apply the material results of the excavations as a check upon the references to Seleucia and the contemporary East in our classical sources. A great deal has been accomplished in Germany in the way of collating such references.[3] Unfortunately, interest in the trans-Euphrates lands during the period between the death of Alexander the Great and the rise of the Sassanian Empire has been slack. As a result, even standard historical works that mention Seleucia draw an erroneous picture of the political and cultural background of the city. In large measure this has been due to a failure to apply to passages in the classical writers which concern the East the same critical analysis that has served to elucidate obscure and conflicting accounts dealing with the West.

Aside from the Greek and Roman authors, much of value for an appreciation of the environment in which Seleucia was developed may be gleaned from Babylonian (cuneiform) texts of the Seleucid and Parthian periods, and from the writings of the

[3] Fabian, E. E., *De Seleucia Babylonia* (Leipzig, 1869); Schneiderwirth, J. H., *Seleukia am Tigris* (Heiligenstadt, 1879); Streck, M., *Seleucia und Ktesiphon* (Leipzig, 1917); and Streck, M., in Pauly-Wissowa, *Real-Encyclopädie*, Zweite Reihe, II, article "Seleukeia am Tigris."

Arab geographers of the Middle Ages.[4] But little of this material has found its way into standard historical works.[5] Excavations that have been carried out at other sites in Mesopotamia and Babylonia during the past century have uncovered a large amount of material that is germane to a study of Seleucia. Unfortunately, the interest of the excavators has been directed in large measure to the more ancient civilizations, with the result that the upper, or later, levels of these sites have received but a cursory examination. In the museums of America and Europe a considerable volume of material from these sites may be found which is labeled either Neo-Babylonian or Achemenid or else Sassanian or Arab, but which properly belongs to the medial period that was contemporary with the life of Seleucia.

Upon the completion of the Michigan campaign at Seleucia and of the study of the results, there will be available a large amount of material, in itself of great value. This will serve in addition as a means of placing in proper perspective and of correlating the earlier material, whether literary or archaeological, that is concerned with the same period. The short sketch of Seleucia that follows illustrates the interrelation of the various sources of our knowledge. It is to be understood that many of the conclusions are tentative, and that all represent my personal view, not necessarily the official conclusions of the Expedition, which in many instances have not yet been formulated.

Seleucia was founded by Seleucus Nicator. Regarding this there is no disagreement among the classical writers.[6] From these sources, however, a definite date for the event cannot be estab-

[4] Streck, M., *Die alte Landschaft Babylonien nach den arabischen Geographen* (Leiden, 1900): cf. the description of Mesopotamia, based largely on the Arab writer Serapion, by Guy le Strange, *Journal of the Royal Asiatic Society*, 1895, pp. 1–76, 255–315, 739–749; Clay, A., *Babylonian Records in the Library of J. Pierpont Morgan* (Yale University Press, 1912–23); Schroeder, O., *Kontrakte der Seleukidenzeit aus Warka* (Berlin, 1916); Strassmaier, J. N., "Arsaciden Inschriften," *Zeitschrift für Assyriologie*, 3 (1888); and others.

[5] As an exception should be noted the second edition of *Griechische Geschichte* (Berlin-Leipzig, 1927), by Julius K. Beloch, with especial reference to Volume IV. The bibliographies in Volumes VII and VIII of *The Cambridge Ancient History* are of course very full.

[6] Strabo 16.1.5; Pliny, *Nat. Hist.* 6.30 (§ 122); Appian, *Syr.* 58; Amm. Marcell. 23.6.23; Georgius Cedrenus (in *Corp. Script. Hist. Byzant.*, 1 : 292).

lished. In the British Museum there are two fragments of a tablet, the copy of an official chronicle relating to events during the first decade after the death of Alexander.[7] Lines 9–11 of the Obverse read: "In the sixth year of Philip, in the month of Elul, the satrap of Akkad with silver of the silver . . . . plant . . . and all the troops of Akkad he set there, the silver in half-shekel pieces (?) . . . . . of Akkad the good doors of the town wall to Dur- . . . . ." Farther on in the account (Reverse, line 8) may be read: ". . . In the midst . . . Seleucus from Babylon to . . . which is on the Tigris . . . they went out . . ." The sixth year of Philip (son of Alexander the Great) is equivalent to 319–18 B.C. "Satrap of Akkad" is the title of Seleucus before he proclaimed himself king. Half-shekel pieces were very small silver units. *Dur-* is an old stem commonly used in Assyria and Babylonia as a term for fort or stronghold. On the first passage Mr. Smith comments: "The doors are obviously needed for some rebuilding on an old site by Seleucus. . . . There is nothing to show which of Seleucus' numerous foundations is here intended." In reference to the second passage he states: "It is tempting . . . to suppose that this is the city [on the Tigris] for which the materials mentioned in Obverse 9–11 were required. In that case Seleucia stood on an ancient site the name of which began with *Dur-*. There is nothing to show that Seleucus did not begin work on Seleucia in 320 B.C., but the hypothetical interpretation of these fragmentary lines is not sufficient evidence to prove that he did so." Mr. Smith was probably unaware of an interesting fact, that the present native name for the small district comprising the lands immediately around the site of Seleucia is "Dura." So far as the natives of the region have knowledge, the name has been handed down from ancient times. As a general rule in Mesopotamia the use of the stem *Dur-* as a part of a modern place-name is indicative of the close presence of an ancient site which comprised a stronghold of some sort.[8] It is probable, therefore, that in the neighborhood of the site of Seleucia there existed in antiquity a stronghold. The fortifica-

[7] Smith, Sidney, *Babylonian Historical Texts* (London, 1924), p. 124.
[8] Cf. Cumont, F., *Fouilles de Doura-Europos* (Paris, 1926), pp. 10–13.

tions of Seleucia would scarcely have received a Semitic name apart from that of the city; the "Dura" must have antedated the completion of the building of the new foundation. Opis, beside which the new city was built, must have been assimilated within it. The older city last appears by name in the accounts of the campaign of Alexander. There is no mention of its later destruction; the name simply disappears.[9] In decribing the head of navigation on the Tigris Strabo employs the phrase *τὴν Ὦπιν καὶ τὴν νῦν Σελεύκειαν*, "Opis and the present Seleucia."[10] This clearly implies the unity of the two sites. Now the same author in another passage referring to Opis characterizes it as a *κώμη*, an "unwalled town," and in describing the foundation of Seleucia by Seleucus he uses the word *ἐτείχισε*, "he fortified," or "encircled with walls."[11] Appian gives a rather detailed account of the formal act of foundation.[12] He describes the army of Seleucus drawn up awaiting the auspicious moment for starting work in the presence of Seleucus and the Magi. This corresponds with the statement in the Chronicle cited above that "all the troops of Akkad he set there." Troops would not have been employed to construct dwelling quarters, but rather fortifications. Appian's account suggests the formality of the occasion. The distribution of largesse in connection with dedication ceremonies is, of course, a very ancient custom. The reference in the Chronicle to the preparation of a quantity of silver in coins of a small denomination is very suggestive of such a distribution. The survival of the place-name Dura in reference to the immediate neighborhood of Seleucia and the common elements in the accounts from the Babylonian text and from the Greek authors point strongly to an identification of the Dur[ ] constructed by Seleucus in 319–18 B.C. with the first, or formal, foundation of Seleucia. This formal foundation of the new city, so far as actual construction was concerned, comprised, I believe, simply the erection of a Seleucid stronghold at Opis, a strategic point on the highway to Persia. This operation may have included the placing of walls around the old city, but was not concerned with the con-

[9] Pauly-Wissowa, *Real-Encyclopädie*, article "Opis."
[10] Strabo 16.1.9. [11] *Ibid.* and 16.1.5. [12] Appian, *Syr.* 58.

struction of new residential quarters. The settling in Seleucia of large masses of colonists is ascribed to Seleucus by the classical sources.[13] That this is not true for the inhabitants of Babylon, who were removed to the new site by Antiochus I, has been demonstrated by Babylonian texts.[14] The results of the excavations throw interesting light on the situation. There have been recovered a number of coins and clay medallions that belong to the period between the death of Alexander and the assumption of the royal title by Seleucus. Some of these pieces bear the types and the name of Alexander; they are followed by others with the types of Alexander, but the name of Seleucus. A few coins might find their way from other centers to a city of later date, but this can scarcely be true of the series of clay medallions recovered in the excavations, which continues through the reign of Antiochus. I accept these coins and medallions as evidence that the site was occupied by Seleucus from as early as 320 B.C., whether it was called at that period Opis, Dur[ ], or Seleucia. On the other hand, the great body of material from Seleucia that concerns the development of the administrative forms of the Seleucid government goes back only to the time of Antiochus, apparently to the period of twelve years from 293 to 281 B.C., when he was associated with his father and ruled the eastern portion of the empire with Seleucia as his capital.[15] As has been stated, above, vertical cuts to water level have been made at two points on the complex. The one cut revealed the remains of what was probably a temple area; the other formed part of the great residential quarter. In both instances the earliest date to which the architecture can be assigned, by the evidence of coins and inscribed objects, falls within the same period, from 293 to 281. On the basis of the evidence now available, therefore, it appears that a foundation was made by Seleucus on the site of Seleucia around 319 B.C., but that the actual settlement of large numbers of new families, as distinct from the population of Opis,

[13] Pliny 6.30 (§122); Pausanias 1.16.3; Josephus, *Ant. Iud.* 12.3.1; 18.9 ff.; Georgius Cedrenus, *loc. cit.*

[14] Smith, Sidney, *op. cit.*, p. 153; Rostovtzeff, M., "Syria and the East," *The Cambridge Ancient History*, 7: 187–189. [15] Appian, *Syr.* 62.

and the organization of the royal civil administration in Babylonia took place much later. It is reasonable to suppose that veterans whose terms of military service had expired were located in Seleucia at intervals after the formal foundation. Extensive settlement, however, probably was due to the establishment of the court of Antiochus in Seleucia in 293 B.C. At what date occurred the organization of the *polis* of Seleucia has not yet been determined. A large Hellenic population would not have been a prerequisite for the granting of a city constitution.

Seleucia, along with all of the Empire east of the Euphrates River, was lost to the Seleucid kings through the expansion of the Parthian power. This people, probably originally Iranians from the steppes, somewhat primitive in culture but hardy and warlike, from a small nucleus in the region to the southeast of the Caspian Sea, had developed an empire in the Middle and Near East that for nearly four centuries was to rival Rome herself. The occupation of Seleucia by the Parthians took place at some time during the reign of the Seleucid king Demetrius II, and that of the Parthian, Mithradates I. Cuneiform tablets are known for 144–43 B.C. with the name of Demetrius, and for 141 B.C. with that of Mithradates.[16] Such tablets as a rule originated in the Babylonian temples, always conservative in their policies. Though it is possible that temple officials might continue to date their documents by the reign of a given king for some months after he had ceased to rule, they could hardly be accused of overhaste in acknowledging the accession of a new king or, more especially, of a new dynasty. The fact that by 141 B.C. tablets were being dated in the name of the Parthian dynasty suggests strongly that the occupation of Babylonia took place as early as the preceding year. The classical sources are in this instance useless. Justin and Orosius both refer to the general advance of Mithradates, but with little or no detail. Rawlinson, however, has noted a point of interest. Justin takes the pains to state that certain regions to the east of Babylonia offered resistance to the Parthians; that he does not speak of fighting in the latter province may be taken as presump-

[16] Strassmaier, J. N., "Zur Chronologie der Seleuciden," *Zeitschrift für Assyriologie*, 8 (1893) : 110; Schroeder, *op. cit.*, No. 37.

tive evidence that it surrendered without a struggle.[17] From the excavations there have been recovered a few coins of Demetrius II. Of greater importance is the impression of a seal bearing his portrait, that was found in a room of the latest occupation of the lowest (fourth) level of architecture in the city block to which reference has been made. The impression formed part of an archive of business documents. The archive and building were destroyed by fire either during or just after the reign of Demetrius. Beginning with the level next above we find the autonomous coinage of the city issued under Parthian suzerainty. So far as the evidence from the excavations is concerned, it is not possible to determine whether the destruction occurred at the time of the occupation by Mithradates or shortly after. This is due to the slight extent of the area uncovered in the lower levels. Babylonia was reoccupied for short periods by Demetrius II in 140 B.C., and by Antiochus VII in or about 130.[18] During the latter campaign there were disturbances within the city.[19] To this rather than to the occupation by Mithradates may be due the burning of the fourth level.

With four brief exceptions Seleucia remained a part of the Parthian Empire to the end of the city's life. These exceptions comprise four great political and military events that have left their traces for the eye of the excavator. About 36 A.D. the city revolted and was restored to Parthian control only after seven years.[20] The date for the opening of the revolt has been fixed by Gutschmid through a careful interpretation of the chronology of contemporary events as related by Josephus.[21] The results of the excavations have served to confirm the German author. As has been stated above, the third level of architecture is marked by the presence of autonomous coins of Seleucia. Parthian bronze pieces do not occur. In the second, or later, level civic coins are

[17] Justin 41.6; Orosius, *Paulus* 5.4.16; Rawlinson, G., *The Sixth Great Oriental Monarchy* (London, 1873), p. 77, note 2.

[18] Justin 36.1.1–5; 38.10.2; Orosius, *Paulus* 5.10; Wroth, W.W., *Catalogue of the Coins of Parthia* (London, 1903), p. xxi.

[19] Diodorus Siculus 34.19. [20] Tacitus, *Annals* 11.8–9.

[21] *Ant. Iud.* 18.9.8; Gutschmid, Alfred von, *Geschichte Irans* (Tübingen, 1888), pp. 124 ff.

entirely replaced by Parthian. The latest autonomous coins bear the date 42–43 A.D.; the earliest Parthian bronze that of 43–44 A.D. That is to say, an event took place in 43 A.D. that resulted in the withdrawal of the right on the part of Seleucia to issue her own bronze coinage. Corresponding to this change in the currency are abrupt differences in the cultures represented by the third and the second levels. The building of the older level in the block was typically Hellenic, that of the second, entirely Oriental. Though objects showing a Hellenic tradition are common in the earlier levels and the Oriental influence is slight, beginning with the first occupation of the second level the contrary is true. This crisis that involved radical cultural as well as political changes can be explained only on the basis of the revolt, and the city must have returned to her allegiance in 43 A.D. If we accept the statement of Tacitus cited above that the revolt lasted seven years, the date determined by Gutschmid is proved correct.

About 116 A.D. the Roman emperor Trajan invaded Parthia and occupied Babylonia. The principal source for this narrative is Dio Cassius, who fails to mention Seleucia by name in his account of the advance. Orosius and Eutropius, however, name Seleucia.[22] Later Dio describes a revolt which broke out in the rear of the Roman army while Trajan lingered in southern Babylonia. Among the rebel cities a "Seleucia" is mentioned, which was captured and burned in reprisal by the Romans. Older writers such as Rawlinson have assumed that the city was Seleucia on the Tigris; others, represented by Streck, have held that, since the rest of the places mentioned lay in northern Mesopotamia, the reference is to a Seleucia on the Euphrates.[23] The excavations within the city block have revealed the débris of a major conflagration that, on the evidence of the coins which have been read to date, occurred between 113 and 120 A.D. The remains of another extensive fire were uncovered in the temple area, which at present may be dated only as of the same century. The evidence, though incomplete, is suggestive of a confirmation of Rawlinson's assumption.

[22] Dio Cassius 68.26–29; Orosius, *Paulus* 7.12; Eutropius 8.3.

[23] Rawlinson, *op. cit.*, p. 313; Streck, in Pauly-Wissowa, *Real-Encyclopädie*, Zweite Reihe, II, article "Seleukeia am Tigris."

Another Roman army under Avidius Cassius invaded Babylonia in 166 A.D. The Greek and Roman writers are unanimous in asserting that Seleucia was destroyed during this campaign. Dio Cassius writes *τὴν Σελεύκειαν διέφθειρεν ἔμπρησα*; Zonaras, *καὶ ταύτην ἐνέπρησε*; Ammianus Marcellinus, *incensa civitate.* Eutropius states that 40,000 prisoners were taken, and material for a triumph. Julius Capitolinus decries an attempted excuse for the destruction.[24] Modern commentators have always acquiesced in the supposition that this event to all intents marked the end of the city's existence.[25] The excavations have confirmed the capture of Seleucia in 166 67 A.D., accompanied, probably, by some measure of destruction. The evidence for the date is furnished by caches of money hidden away when the city was attacked. The destruction may be inferred from an extensive rebuilding that took place shortly after the caches had been made. On the block that has been excavated this rebuilding resulted in a residence more spacious and elaborate than any of its predecessors. The general evidence is clear that Seleucia enjoyed a prosperous existence after its "destruction."

For the third time a Roman army occupied Seleucia in 198–99 A.D. as a part of the Parthian campaign of Septimius Severus. The narrative of this event, by Dio Cassius, does not indicate that the city suffered at the hands of the Romans.[26] No evidence of destruction at this date has been disclosed by the excavations. A cache of silver coins, the latest of which is dated in 198–99 A.D., is probably to be connected with this occupation. The latest coins that have been recovered from the site are of the year 214–15 A.D. The condition of the remains of the uppermost level of architecture suggests that gradual decay rather than sudden destruction caused an abandonment of the city. The later resettlement in Sassanian and Arab times referred to above does not concern the history of Seleucia.

[24] Dio Cassius 71.2; Zonaras 2:527; Amm. Marcell. 23.6.23; Eutropius 8.10; Jul. Capitol., *Hist. Aug., Ver.*, 8.3.

[25] Rawlinson, *op. cit.*, pp. 327 ff.; Gutschmid, *op. cit.*, p. 149; Streck, *loc. cit.*; Wroth, *op. cit.*, p. lxi; Hill, G. F., *Catalogue of the Greek Coins of Arabia, Mesopotamia, and Persia* (London, 1922), p. cxvii.

[26] Dio Cassius 75.9.

Seleucia was perhaps the largest city of the Hellenistic period. Pliny, about 77 A.D., estimated the population at 600,000; Orosius, describing a period nearly a century later, gives the figure as 400,000. As quoted by Sallust, Mithradates the Great of Pontus described Seleucia as "maximam urbium." Strabo says of Antioch that the Syrian city was not much less powerful or smaller than Seleucia or Alexandria.[27] The economic basis for the size of Seleucia is not directly stated by any of the ancient writers. It is generally agreed that transit trade was the principal source of the wealth of the great Hellenistic centers.[28] The geographical location of Seleucia determined its importance as a center of trade. The caravan routes from Central Asia, China, India, and Persia converged on Seleucia. Thence to the west they spread out to Damascus and the Phoenician coast on the south and to the great ports of Asia Minor on the north. From India, Africa, and Arabia seagoing vessels came directly to the wharves of Seleucia. The Euphrates and the Tigris brought to her the produce of Mesopotamia and Armenia.[29]

The shape of Seleucia, according to Pliny,[30] resembled that of an eagle with outstretched wings. The same author describes the Tigris as flowing around the city. It may be gathered from the descriptions that Seleucia was spread out along the banks of the Tigris, which curved around to wash at least two sides of the city. Reference is made by a number of the classical writers to the ship-bearing canal from the Euphrates which joined the Tigris at Seleucia. According to Theophylactus, this canal served as a moat around that part of the city not protected by the river; both he and Pliny describe the canal as flowing through Seleucia.[31] It is to be presumed that the canal comprised two channels, one

[27] Pliny 6.30 (§ 122); Orosius, *Paulus* 7.15; Sallust, *Hist.* 1.4; Strabo 16.2.5.

[28] Tarn, W. W., *Hellenistic Civilization* (London, 1930), p. 220; Warmington, E. H., *The Commerce between the Roman Empire and India* (Cambridge, 1928), p. 18.

[29] Streck, *Seleucia und Ktesiphon*, p. 12; Rostovtzeff, "Syria and the East," *The Cambridge Ancient History*, 7 : 173; Wilcken, Ulrich, *Alexander der Grosse* (Leipzig, 1931), p. 265.

[30] 6.30 (§ 122); 5.26 (§ 90).

[31] Theophylactus Simocatta 5.6; Pliny 6.30 (§122).

of which flowed around the walls, while the other passed through the city proper. At an earlier date Ur of the Chaldees was protected in a similar manner by river and canal.[32] The present complex of mounds has been badly washed by flood waters and is not, therefore, indicative of the shape of the city. The course of the older river bed along the northern and eastern sides of the mounds has been traced, and the remains of the port are plainly visible along the eastern edge. A straight depression through the complex within which no remains of architecture may be found probably represents the one channel of the canal which traversed the city. According to Arab tradition of the tenth century, a brick bridge joined the two banks of the Tigris between Seleucia and Ctesiphon.[33] None of the classical writers mention such a bridge. Polybius devotes considerable space to an account of the campaign of the generals of Antiochus III against Molon in the neighborhood of Seleucia.[34] He describes the extensive maneuvering along the banks of the Tigris and the collection of all the boats on the river by one side to prevent the passage by the other. In view of the detailed account it is unlikely that a permanent bridge structure would have escaped mention in the narrative. Yet the tradition does impress one; it is stated that even in Arab times the ruins of the bridge formed a menace to navigation in low water. That some sort of bridge did exist in the Seleucid period must be admitted. Even at low water it is not practicable to ford the Tigris. The traffic over the river, both commercial and military, was heavy and of vital importance. I suggest that there was a bridge of boats retained on each bank by permanent bridgeheads of brick. In modern times the boat bridges in the Orient have such approaches that lead out over shallow water to the main channel in which the boats are swung. It was doubtless the ruins of one of these structures that formed the basis for the Arab tradition.

The ethnic characteristics of the population of Seleucia are

[32] Wooley, C. L., *The Museum Journal*, The University Museum, Philadelphia, 21 (June, 1930), Part 2.

[33] Streck, *Die alte Landschaft Babylonien*, p. 269; Iṣṭahri, *Masalik ul Mamâlik*.

[34] Polybius 5.51–54.

involved. We have first of all the population of Opis, that was assimilated within the new foundation, and the inhabitants of Babylon, who, according to cuneiform texts as well as classical sources, were removed to Seleucia.[35] This stock was predominantly Semitic, although the Iranian elements resulting from the long occupation of Babylonia by the Achemenid dynasty must not be overlooked. Indeed there are certain indications suggestive of a strong Iranian influence in Opis. Babylon was, of course, the Persian capital in Babylonia, but Opis guarded the Tigris crossing and the highway to Persia. It must have been, therefore, a center of importance in the Achemenid administration. It is to be noted further that Opis was the scene of the famous banquet given by Alexander the Great at which he proposed a fusion of Greek and Iranian elements in army, politics, and religion.[36] The choice of Opis as the scene of this important announcement suggests that Opis was a center of Iranian settlement in Babylonia. In the account left by Appian of the foundation of Seleucia it is stated that Seleucus ordered Magi to determine the propitious hour for the inauguration of construction.[37] Now the term "Magi," if properly used, refers to Iranian, not Babylonian, religious practice. It is not impossible, however, that Appian used the word in a general sense for Oriental priests. On the other hand, the Magi who had been present at the banquet of Alexander on the same spot only a few years previously were Persians, a part of the Iranian influence which Alexander was seeking to win.[38] It is probable, therefore, that the augurs described by Appian as Magi were Iranian. According to the narrative, the Magi attempted to deceive Seleucus concerning the propitious hour, but by a miracle their plot was frustrated. Later, in their defense, the priests identified themselves with the locality and with the people around the new site. If, then, the Magi were Iranian, the same element must have been influential, perhaps predominant, in Opis. It must not be forgotten that the wife of Seleucus, the mother of Antiochus, was an Iranian

[35] Smith, *op. cit.*, p. 153; Pliny 6.30 (§ 122); Pausanias 1.16.
[36] Wilcken, *op. cit.*, pp. 206–210. [37] Appian, *Syr.* 58.
[38] Wilcken, *loc. cit.*

princess, whom Seleucus married as a part of Alexander's program for the fusion of Greek with Iranian.[39] It is not unnatural, therefore, that her influence would be felt in the location of a site for the new capital. In the course of the excavations there was uncovered the stone base of a column decorated in a motif distinctively Persian of the Achemenid period. Since stone quarries were not native to Babylonia, the use of this material in construction is indicative of a building of great importance. This piece, consequently, must be presumed to represent the remains of a Persian palace in Opis. The evidence as a whole is sufficient to establish a strong presumption that Opis contributed to Seleucia a considerable Iranian element.

The classical writers as a whole stress the preponderantly "Greek" character of Seleucia. Pliny, writing about 77 A.D., stated that Seleucia still retained "Macedonian manners [*mos*]"; Tacitus remarked, probably about 115 A.D., that the city "still bears the impress of its founder, Seleucus, and has never lapsed into barbarism"; Dio Cassius testified, in the period between 212 and 225 A.D., that Seleucia was a city "having even at the present day chiefly a Greek population."[40] At first glance this appears to be convincing testimony, and the greater number of modern writers have thought of Seleucia as the center of Greek life and culture in the Orient to the end of its existence. Certain contradictions, however, appear in the classical sources themselves. Pliny and Pausanias have been cited as stating that the population of Babylon was removed to Seleucia. Babylon had been the greatest city of the world. It is difficult to believe that the Greek element in Seleucia outnumbered the Orientals drawn from both Babylon and Opis to the extent that Dio Cassius implies. Owing to the large Jewish population of Babylonia and to the close relations maintained by them with Jerusalem, Josephus was probably in closer touch with conditions in Seleucia than were contemporary Greek and Roman writers. The Jewish author states that Seleucia "was inhabited by many of the Macedonians, and by more of the Greeks; not a few of the Syrians also dwelt there." It is generally

[39] Arrian 7.4.
[40] Pliny 6.30 (§ 122); Tacitus, *Annals* 6.1; Dio Cassius 40.16.

agreed that by "Syrians" is to be understood "natives."[41] In the same chapter Josephus relates that the Jews of towns around Seleucia fled into the city to avoid persecution, and that the "natives" of Seleucia, that is, the Babylonian-Iranian element, by the help of these refugees were able to wrest the power from the "Greeks." That a group of refugees was able to overturn the balance of power for the control of Seleucia indicates that there was no great difference in the strength of the two parties, "Greek" and "native." The events of which Josephus wrote took place in the first half of the first century A.D., prior to the periods in which Pliny, Tacitus, and Dio Cassius made their estimates of the character of the city's population.

The results of the excavations throw considerable light on the problem. It has been stated that four levels of architecture have been uncovered in the city block. Each level represents one building, occupying the whole of the block and forming the residence of private individuals of standing in the community. The fourth, or lowest, level covers the period during which the city formed a part of the Seleucid Empire. The third level coincides with the period of the autonomy of Seleucia within the Parthian Empire, from about 142 B.C. to 43 A.D. The second and first levels represent the rest of the city's existence. The architecture of the fourth level and the objects found in association with it are definitely Hellenic. The third level remains Hellenic in respect to the architecture, but we begin to find here material that indicates a partial Hellenization of Oriental elements. In the second level there comes a complete break. The architecture is characteristically Oriental, and the associated objects show little or no Hellenic influence. This condition persists through the first level. On the site of the second vertical cut the architecture of the upper levels appears to be similar to that of the corresponding levels in the block, that is, Oriental. It has not been possible to judge of the culture represented by the lower levels in this cut. The objects uncovered in the numerous trial trenches, sunk as a rule into the upper two levels, are characteristically Oriental.

[41] Josephus, *Ant. Iud.* 18.9.8. See Streck, in Pauly-Wissowa, *Real-Encyclopädie*, Zweite Reihe, II, article "Seleukeia am Tigris."

Several hundred seal impressions found in rooms of the fourth level in the block constitute an important body of evidence. The impressions represent seals of business men in Seleucia, probably merchants or executives of rather more than average importance. The group possessed a culture decidedly Hellenic rather than Hellenized, but included a very few individuals who were Babylonian or Iranian. To judge by the motifs of their seals, there was little or no military tradition. The greater part of the types represented deities, of whom Athena was the favorite, followed by Apollo and Artemis. None of them are of a bacchanalian character, nor are any obscene. The wanderings of Ulysses appear to have exercised an unusually strong hold upon their imaginations.

The evidence afforded by the excavations points to a deep imprint of Hellenism upon the character of the population during the third and second centuries B.C. and to the predominance in the life of the city of individuals actually of Greek or Macedonian descent. A process of Hellenization of native families must have been operative from an early period. The results of this were beginning to show in the character of the culture of the city during the first century B.C. and the opening years of the succeeding century. About 43 A.D. the effects of this process, together with all Hellenic influence, appear to have been wiped out, to be replaced by a culture that was essentially indigenous, that is, Babylonian, with which were mingled elements showing Iranian and Central Asian tradition. This tremendous change can be satisfactorily explained only by an assumption that from the beginning there was in the population a large native element. During the period of the vigor of western domination this important group had been submerged and unable to express itself. For brief periods it might come to the surface in revolt, as it did under Molon toward the close of the third century B.C. Each succeeding rebel against constituted authority, whether Seleucid or Parthian, Timarchus, Himerus, Mithradates, Tiridates, appears to find support, from one party in Seleucia, the "native" group. The great revolt ending in 43 A.D. was directed primarily against the traditional ruling class, the Hellenic and Hellenized elements, and resulted in the displacement of a diluted Hellenic civilization by a revived

native culture. The full weight of the evidence afforded by the excavations supports this interpretation of the history of Seleucia. The classical sources themselves, if subjected to a critical study, require such an interpretation. When Tacitus, Pliny, and other writers state that in their time Seleucia was predominantly Greek, they are simply repeating what had been recorded by earlier authors and travelers. The contradictions on the part of the classical writers are due largely to this tendency to repeat what they have themselves read in earlier works now lost. The narrative of events concerning Seleucia is, on the whole, accurate, but the opinions and conclusions copied from the older writers no longer apply to the Seleucia that was contemporary with their successors. An epitome of the history of Seleucia may be found, however, in two quotations, one from Josephus, who was in close touch with Babylonia, the other from Tacitus, the most reliable of our sources. "Now the way of living of the people of Seleucia who were Greeks and Syrians [i.e. natives] was commonly quarrelsome and full of discords, though the Greeks were too hard for the Syrians";[42] and, ". . . when the two [i.e. parties in the city] fall out, each seeks help against the other and the ally called in to help the one ends by lording it over both."[43]

Exactly why Seleucia became deserted we do not know. However, the practically exclusive basis of the city's greatness was commercial supremacy, which in large measure appears to have been due to the foreign elements with whom it originated. Unrecognized by Tacitus and Josephus, the final political victory rested with the indigenous substratum of the population, and this native culture, that by its rebirth and growth to power overwhelmed the influence of the West, may in so doing have become the author of its own destruction.

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[42] Josephus, *Ant. Iud.* 18.9.8.

[43] Tacitus, *Annals* 6.42.

SOME IMPLICATIONS OF AGRICULTURAL PLANNING

VLADIMIR P. TIMOSHENKO

THE problem of economic planning has become real during recent years because the entire world has been passing through a period of economic depression. From many sides may be heard predictions of the end of the capitalistic system as a result of its anarchistic character and the economic chaos peculiar to it. These objections to the system are not new. They are very similar to those made of the capitalistic system during the decades just following the period of the Napoleonic wars. The first serious criticism of the modern capitalistic organization was made in 1819 by Simonde de Sismondi,[1] who discovered for economic science the phenomenon of economic crisis. His criticism was followed later by socialistic writers of that period.

The present post-war maladjustment, which resulted not only in the world-wide business depression, but also in the world-wide agricultural crisis, demonstrated once more in a very acute way the so-called anarchistic character of competitive society. On the other hand, the experience of planned economy in Soviet Russia aroused particular interest in economic planning. Persons only superficially acquainted with the present economic system of Russia are impressed with its planned economy. However, an attentive study of it, especially of the planning of agricultural production, awakens very serious doubts as to its advantages in general and to agricultural planning in particular.

It is necessary to point out here some peculiarities of agriculture which make the planning unusually difficult. As one of the most important of these may be mentioned its greater dependence,

[1] *Nouveaux principes d'économie politique.* 2 vols.

as compared with manufacturing, upon natural conditions. This dependence manifests itself in two forms:

(*a*) *The biological character of the agricultural process of production*, which causes a slower turnover and a longer period of time necessary for readjustment to changing conditions, and also the impossibility of stopping production at a given moment;

(*b*) *The instability* of its most important branch (crop production) because of dependence upon climatic factors.

Instability of crop production results in instability of animal production, too. Fluctuating prices of feed, affected by fluctuations of crops, in conjunction with the long period necessary for increasing or decreasing breeding, produces cyclical fluctuations peculiar to animal production, such as hog cycles, cattle cycles, horse cycles, and the like. The instability peculiar to agriculture makes uncertain any forecasting, which is so necessary for planning. The long period essential for readjustment requires particularly early forecastings of future changes.

The second characteristic which creates problems in planning is the small size of agricultural enterprises, and, consequently, the large number of them. This makes the execution of the plan especially hard. Very often the planning calls for some curtailing of production and reduction of the crop area, and it is difficult to carry out such a plan in the presence of millions of small-scale enterprises, particularly so when new enterprises may be started at any time with only a small allowance for capital expense.

Under such conditions even the agreement upon a definite plan is difficult to arrive at on a voluntary basis. Still more difficult is its execution. The experiences of coöperative organizations, even in such fields of production as fruit growing in California, give illustrations of the failure to control volume of production. Efforts to control production of sugar and rubber demonstrate that even in those branches of agricultural production which are organized mostly upon capitalistic lines — large rubber plantations, plantations of sugar cane or sugar beets operated by large manufacturing establishments — the control of the volume is a difficult problem. As in the other branches of agricultural pro-

duction, here the difficulties that occur are mostly with small producers, native producers of rubber, or small planters of sugar cane.

Agricultural planning would be easier and more effective with a decline in the number of enterprises, which would mean an increase in the size of productive units. But it is not quite clear that agricultural organization is developing in such a direction. The Marxian socialistic school, at least its Communistic branch, insists that in agriculture the direction of evolution toward large-scale production and toward the factory type is the same as in manufacturing production. However, objective evidence shows that, even if such evolution exists, it is much slower than in the manufacturing industry. At present, such new inventions as tractors, combines, and similar things point to certain tendencies toward increasing the advantages of large-scale production in some branches of agriculture (small grains, for instance), but on the whole agricultural economists believe that the family type of farm will persist for a long time even in such a country as the United States of America, where the problem of economy of labor and its replacement by machines is of greater importance than in other countries, for instance in those of Europe, with their denser agricultural population.

It is of interest to mention that the rigid planning of agricultural production was first realized in the country where agricultural enterprises were conducted on the smallest scale and where their number was the largest — in Soviet Russia. The government first tried to plan and to direct production there when it was still organized in millions (between twenty and twenty-five) of small peasant farms. Such a scheme was initiated about 1919–20, but it resulted in so great a contraction of production that unfavorable climatic conditions caused the famine of 1921–22. Under such conditions the Soviet Government was obliged, after 1921, to renounce the planning of agricultural production and to accept the New Economic Policy, leaving more freedom to the individual initiative of peasants. Such policy continued until 1927–28. But about 1928 the new scheme of agricultural planning was started. As a preliminary condition it required greater con-

centration of agricultural production in a smaller number of large-scale productive units. The organization of collective farms, each composed of many individual, peasant households (about seventy-five to one hundred), and of large state farms was necessary in order to start the planning according to the new scheme. Even separate collective farms were recognized as being too small and too numerous to permit direct planning. In recent years the Soviet Government has found it necessary to concentrate all collective farms (of which there were more than a hundred thousand) around a small number of so-called machine tractor stations (M.T.S.), which control all modern machinery at the disposition of Russian agriculture — tractors, harvesting machinery, etc., and sometimes even horses. There were about fourteen hundred such stations during the summer of 1931. It is expected that there will be from two to three thousand for this year (1932). They, together with huge state farms, command practically all tractors and some other machinery, and in this way they direct the agricultural production of collective farms, which were deprived completely of their own tractors during the spring of 1931. Machine tractor stations concluded with collective farms (and individual farms in their regions) contracts for the delivery of agricultural surpluses. In such manner the total production by the peasantry is regulated by the government in two ways: (*a*) by the concentration of all modern machinery in stations; (*b*) by the monopoly of the purchase of agricultural products. Some people believe that in this organization the Soviet Government has found the means of controlling and planning agricultural production. However, attentive study of the working of this system shows its shortcomings. In large circles outside Russia there prevails an opinion which gives a somewhat exaggerated appraisal of the planned economy of Russia in general and of its agriculture in particular, but a more careful analysis of conditions shows that in this planned economy there is perhaps much greater chaos than in the capitalistic anarchistic economy of other countries, even at the present time of post-war maladjustment.

Only by rough compulsion was it possible to achieve the concentration of the total agricultural production of Soviet Russia

in a small number of productive units. This use of force is itself objectionable from the point of view of people accustomed to some degree of economic and political freedom. Furthermore, the compulsory collectivization in Soviet Russia produced economic consequences which perhaps overbalanced all possible advantages of this system of planned economy. The principal purpose of collectivization and of agricultural planning was to increase grain production. But compulsory collectivization resulted in such a destruction of other branches of agriculture — particularly of the livestock industry — that the whole plan was upset, and now the Soviet Government has to make enormous efforts to replace horses by tractors and to recover the disorganized livestock industry. In such a case, when the planning of the expansion of one branch of agriculture results in the destruction of another and when finally the total expansion of agriculture is jeopardized, it is difficult to speak of planned economy. In any event, the plan to expand the total agricultural production by such a method has not as yet been achieved. If it is difficult to arrive at a limitation of agricultural production in competitive economy, in the planned socialistic economy of Soviet Russia the difficulty is still more serious, since it has not resulted in sufficiently increased production. This difficulty has not as yet been solved, even though Soviet economy has had at its disposition such powerful means as: (*a*) complete state monopoly of the supply of manufactured products for the population; (*b*) the monopoly of the purchasing of agricultural products; (*c*) the complete nationalization of land; (*d*) the absence of any political and economic freedom of the population. For these reasons the experience of Soviet Russia in the planning of agricultural production, which awakened such an interest in economic planning abroad, may be considered as an argument against it rather than in favor of it, at least against it through compulsory control and direction by the state.

If we eliminate such activities from our consideration, then there remain to be analyzed the methods of agricultural planning which are compatible with the present organization of production in numerous independent enterprises of small size. The alternative possibilities are: (*a*) the planning and the control of agri-

cultural production by voluntary coöperative associations of producers; (*b*) control by the state through influencing (directly or indirectly) the activities of individual producers.

We presented the difficulties of the first method above in connection with remarks on the multiplicity of small producers peculiar to agriculture. It is very difficult under such conditions to create a stable and powerful coöperative organization which can control the execution of a plan. Under actual conditions of coöperative organization one may hardly expect direct planning and effective control of the execution of a plan by voluntary coöperative associations of agricultural producers. For this reason the planning and the control of agricultural production by such organizations of producers may be considered only in connection with control by the state. Coöperative associations may be subsidiary organizations helping the state.

The control of agricultural production by the state may be either through direct compulsion of producers or indirectly. The former alternative assumes the methods which we have discussed in connection with the Soviet planned economy and which we have eliminated from further consideration. The indirect influencing of production by the state may be either by control of the prices of agricultural products or by affecting individual producers by some kind of educational activity. The control of production by control of credit facilities for agriculture may also be considered. The amount of agricultural production depends, however, only remotely or not at all upon the volume of credit. For this reason the method which is perhaps the most effective for the control and planning of the volume of manufacturing production is of smaller importance for the control of agriculture.

In the competitive, capitalistic society the price is the principal guide to an individual entrepreneur, and, if we assume the continuance of a competitive economy, the best way to affect its activity in an indirect way is to control the prices. But it is known that this is the problem which is the most difficult to attack by the state. The experiences with price fixation or with the influencing of prices by the state have been rather discouraging. Frequently they produce quite unexpected results. Such policies

as the valorization of coffee in Brazil or the recent pegging of the wheat prices by the Farm Board in this country are considered by many persons as responsible for a still greater decline in price.

The countries producing for domestic consumption only are in a better position in this relation. They have a much greater possibility of controlling prices of agricultural products by protective tariffs. The experience of agricultural protectionism in some European countries before the war, such as Germany, for example, has shown that the government in such countries can plan some agricultural development and execute such a plan by control of prices through protective tariff. The increased production of bread grains in pre-war Germany and the development of the animal industry were planned by the government, and the plan was executed through the policy of a protective tariff for bread grains and animal products and by keeping prices low for imported forage grain. The control of freight rates by the government has the same possibility as that of prices.

The control of prices in order to influence production is, however, much more difficult in countries exporting surplus agricultural products, as may be seen from the results of the recent policy of the Farm Board in regard to wheat and cotton prices in the United States. These place some limits on governmental planning and control of agricultural production in such countries. For them there remains perhaps only one possibility of affecting production in the desired direction; that is by influencing the activity of individual farmers in some educational way. The practice introduced by the Bureau of Agricultural Economics in this country of preparing each year during the spring months a national survey for the coming season may be considered a policy which may to a substantial degree facilitate and hasten the adjustment of agricultural producers to new conditions. As has been mentioned above, the difficulty with agriculture is that it can adjust itself to new conditions only very slowly. Any activity of the state which may hasten the readjustment of individual farmers to new conditions by presenting to them all information which they need in comprehensive form and by teaching them to use this information may be of greater importance than a direct

influencing of agricultural production. From this point of view publications by some governmental office of (*a*) information about foreign markets, (*b*) information about domestic production and prices, (*c*) agricultural outlooks for the season, etc., may be in actual practice much more useful than any direct agricultural planning by the state.

The problem is to hasten the individual adjustments of farmers to changing conditions rather than to produce some elaborate governmental plan of readjustment. Such calamities as the agricultural crisis which we are suffering at present are not very frequent. During more than a hundred years since the Napoleonic Wars the agricultural world has passed through perhaps three crises, one immediately after the Napoleonic Wars, one from 1870 to 1900, and a third since the World War. Crises in agriculture are not such recurrent phenomena as those in business. Only very far-reaching changes in environment such as world wars, which cause great changes in price levels, or such innovations as the complete reorganization of the transportation system which took place in the middle of the nineteenth century through the introduction of railroads and steamships, may result in a world-wide crisis of agriculture.

Agriculture is slower in its adjustment to new conditions than is the manufacturing industry, but on the other hand it is less sensitive to changes than are business and trade. It is more difficult to upset the equilibrium of agriculture than that of manufacturing and trade. If some kind of international organization should eliminate world wars and great and sudden changes of the price level, the most important factors which tend to disturb agriculture would disappear. No doubt the far-reaching changes in technique, such as the introduction of tractors at the present time, may also disturb the equilibrium of agriculture in different countries or in regions of the same country differently affected by the use of such new inventions. To such changes, however, agriculture may better adapt itself through individual adjustments of farmers assisted by the state and coöperative organizations than through some direct planning by the state. The conditions which dominate world economy at the present time are created

by the unprecedented World War and cannot be considered as normal or typical conditions to which agriculture has to adjust itself in more usual times. But partly because these conditions are abnormal, they could not be forecasted in any way, and for this reason no far-reaching plan of readjustment to them could be elaborated by the state or by any other organization. The individual adjustment of agriculturists is the only issue from these abnormal conditions, and the rôle of the state is merely to facilitate and to hasten these individual adjustments, rather than to create some plan of reorganization and to control its execution.

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A STUDY OF POPULATION IN VERMONT AND NEW HAMPSHIRE

STANLEY D. DODGE

THE mapping of areas of declining population may reveal the places where economic, social, and political problems affecting the people living in them are acute, as well as locate areas of interest because of the significant changes that have occurred in geographical details as a result of depopulation. Major geographical features fundamental to the more vital concerns of the people in the areas of decline may be determined by field studies of depopulated regions. On the other hand, areas in which population has continued to grow present somewhat contrary problems, both social and geographical, which are of equal interest. The following paragraphs indicate the methods employed in a preliminary study of the distribution of categories of population growth and decline in Vermont and New Hampshire.

Theoretically, the population of any area may increase till the limits of subsistence are reached. In some cases world trade makes the problem complex in the extreme by stretching the subsistence area to cover almost the whole surface of the earth. Most areas, however, are on the fringe of world trade, and such complexity is not a matter of tremendous concern when local areas are studied by themselves, although it does form a background for, and an important explanation of, many larger population groupings. Relying on the theory of population growth as advanced by a long succession of workers from Malthus to the present day, and taking what seem to be the logical studies of Pearl as a starting point, we may study the growth of population graphically, and the categories of growth thus arrived at may be distributed on a map.

The ideal population curve of Pearl is based on statistical evidence from a variety of population groups, those of human

beings as well as those of controlled laboratory populations of flies.[1] The curve may be likened to a stretched out S (Fig. 3). The conclusion to be drawn from such a curve is that at first populations rapidly increase in numbers, later at a slower rate, and finally reach a certain equilibrium when a point of saturation, or balance between food [2] and population, is attained.

Among the actual conditions in which human populations live, decline in population may be a phenomenon as important as

Fig. 3. Ideal population curve (after Pearl)

growth. Many of the settlements of Vermont and New Hampshire were made shortly before, and during the period of, the American Revolution, which means that within fifty years of their founding the migration of people to the interior of the continent through the Mohawk Valley to Ohio, Michigan, and Illinois had begun to depopulate the less favored parts of the two states. In addition, the contemporary development of manufacturing in southern New England and in scattered spots in the two northern

[1] Pearl, Raymond, *The Biology of Population Growth* (New York, 1925).
[2] Using "food" in a very wide sense so far as human groups are concerned.

states lured many away from the upland to seemingly easier living in the lowland industrial towns.

The ideal population curve of Pearl must, then, be emended to take care of the actual conditions of population in the areas of decline. Growth and decline must both be considered. As a consequence, the population curve becomes ideally a portion of a sine curve (Fig. 4). In this, three phases may be distinguished: growth (A to B), relative stability (at B), and decline. Actually, the second phase may be eliminated for many places, for sometimes the beginning of decline has followed close on the heels of growth, without an intervening period of greater or

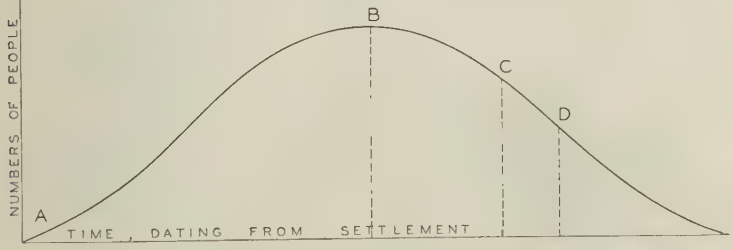


Fig. 4. Ideal population curve, showing both growth and decline

less stability, and probably also before the full limits of support under subsistence agriculture were reached. In addition to the three classes distinguishable on the basis of the foregoing consideration of the sine curve, the phase of decline may be subdivided arbitrarily and may give a phase of partial decline, calculated at more than a quarter of the total possible decline, and one of still greater reduction in the numbers of people, that is, to less than half those inhabiting the area at the peak of population.

In more precise terms four main categories were distinguished:

1. Growth, i.e. decade-to-decade additions to the population (A to B);[3]

[3] Slight dips in the curve, followed by upward recovery, were not considered. Falling off in the census of 1930 was not considered important, for it cannot yet be said what the census of 1940 will show in the way of further growth.

2. Relative stability, i.e. decline insufficient to warrant inclusion in the next category (A to C);

3. Partial decline, i.e. when population has reached a point less than three fourths of the highest total number at any preceding census (A to D);

4. Marked decline, i.e. when population has reached a point less than one hundred more than half of the highest total number at any preceding census (A to beyond D).[4]

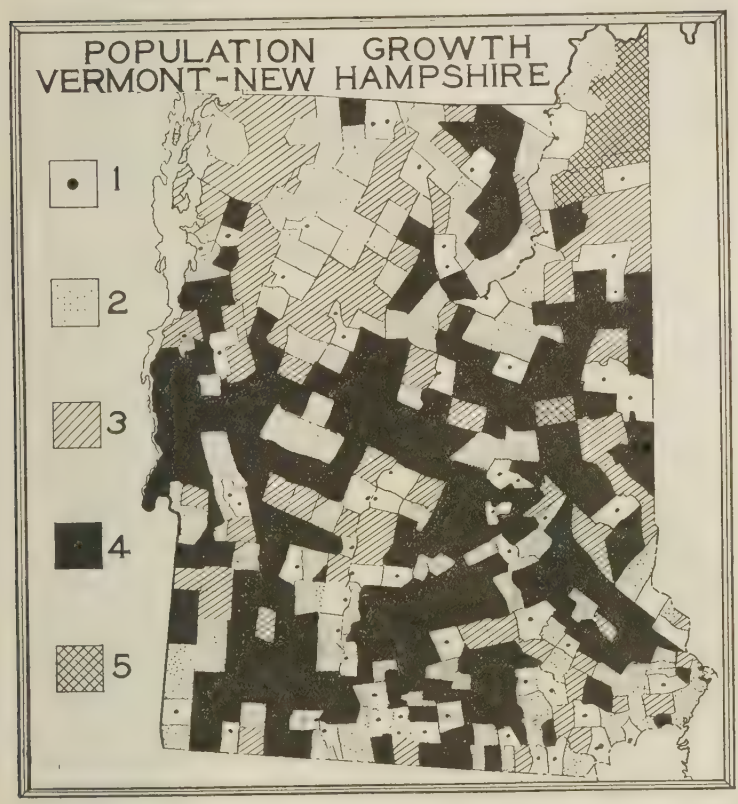
In addition to these categories a fifth was distinguished on the basis of a decidedly unstable population which had never reached a high figure. A typical decade-to-decade recording of such data might give a sequence of figures like these: 45, 1, 19, 111, 0, 2. Presumably they represent lumber areas with fluctuating populations.

Against the assumed theoretical sine curve were placed actual graphs of the rise and the fall of population numbers. On the basis of these comparisons the townships were listed according to the categories in which they fell. Generally, it was the townships that were the smallest areas for which distinct data were available.[5] After the construction of graphs for all the towns in Vermont, it was found that a simple inspection of the census data arranged in convenient statistical form was sufficient to establish the category to which any given township belonged, except for the few doubtful ones for which graphs could be constructed. Thus time and labor could be saved and as satisfactory results obtained.

After the cataloging of the townships on the basis of a direct or an indirect comparison of their data with the ideal curve, the classes were distributed on a township base map (Map 2). The map, then, shows areas of (1) continued growth, (2) relative stability at or near a peak, (3) partial decline, (4) marked decline, and (5) fluctuating and unstable population at a low figure. What may be the significance of the distribution of the areas of marked decline, for example, is hard to say without more detailed work on which solid conclusions may be based. Investigation in

[4] One hundred is an arbitrary figure, introduced because in some places population had declined to within that figure of one half and because on other ground such places were considered to be demographically comparable to those in which population had reached one half, or had dropped to less than that.

[5] Sometimes the data were listed in the census by boroughs, i.e. subdivisions of towns, and in these cases the categories were distinguished on the basis of the smaller unit.



MAP 2. Distribution of classes of population growth in Vermont and New Hampshire by areas. Explanation of legend: 1, continued growth, with chief centers; 2, relative stability; 3, partial decline; 4, marked decline; 5, irregular fluctuating population

Vermont, in the vicinity of Bennington, suggests that the area of marked depopulation shown on a township basis is too small; probably even townships showing continued increase have large depopulated areas.[6] Areas of decline, like Lyme, New Hampshire,

[6] Dodge, S. D., "The Vermont Valley: A Chorographical Study," *Pap. Mich. Acad. Sci., Arts and Letters*, 16 (1931): 241–274.

suggest possible interpretations applying to the whole area.[7] Readjustments in areas of relative stability, such as Windsor, Vermont, bear out the conclusions in respect to the Bennington area.[8] Whatever the conclusions, they may be based only on some map showing as accurately and in as much detail as possible the distribution of categories of population growth and decline.

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[7] Goldthwaite, J. W., "A Town That Has Gone Down Hill," *Geog. Rev.*, 17 (1927): 527–552.

[8] Wilson, H. F., "The Roads of Windsor," *Geog. Rev.*, 21 (1932): 379–397.

WORLD DISTRIBUTION OF POPULATION: PRELIMINARY SURVEY AND TENTATIVE CONCLUSIONS

STANLEY D. DODGE

THE problem of the distribution of population is one of great complexity, not only in the distribution phenomenon itself, but also in its explanation in terms of a multiple complex association of conditioning factors.[1] These latter include not only such geographical data as the kind of climate, the quality of the land surface, the fertility of the soil, and the presence of coal, but also such non-geographical data as "the manner of making a living" (*genre de vie*) and "the kind of food eaten." It is obvious that these two conditioning factors, at least, have some kind of intimate connection with geographical items, but they are not exclusively explained by them, for in many places in the world they are merely parts of an intricate cultural inheritance. Whereas the people of Kwangtung may cultivate rice so completely in harmony with the "natural environment" that that genre de vie may be spoken of largely in terms of geographical conditions, it remains true that in areas of recent cultural change, like the North American Great Plains, the genre de vie is better attributed to non-geographical factors. Southern Chinese rice culture represents the result of a long process of readjustment to a complex environment; western United States, recently taken from hunting Amerinds by an agricultural people of European extraction, is an area in which the new culture is still in the experimental stage, so far as established harmony between genre de vie and natural environment is concerned.

The map of world distribution of population is of interest to the geographer not solely because he may help in the answer to the

[1] Isaiah Bowman has called attention to this problem in *The Andes of Southern Peru* (New York, 1916), p. 47.

intricate question that it poses, but rather because it reveals those areas where particular geographical problems may present themselves. The people on the land are in the geographer's province, because they are on and of the land and the relative density of population is a matter of geographical concern. If the land is to be understood, the "thickness" of the population cover must be known as well.

The facts of distribution, as displayed on the accompanying map (Map 3), have been derived from widely scattered statistical sources, but especially from the latest issue (1929) of Volume II of the *Commerce Yearbook*[2] and the United States census. The actual distribution of dots on the map within the territories for which data are given has been guided by information contained in such regional population studies as those of Semenov Tian-Shansky,[3] P. M. Roxby,[4] and Sten de Geer.[5] The map shows the notable areas of density of population in eastern and southern Asia and western Europe, the small area of dense population in eastern North America, the areas with no population at all (interior Greenland and Antarctica), and the much larger areas of sparsely settled country.

The manner of making a living is itself, as has been suggested, complexly conditioned. Even so comparatively simple a genre de vie as that of the Fang[6] has, nevertheless, a fundamental complexity that is difficult to analyze. The garden agriculture (*Gartenbau*) of certain Oriental plains would seem to be more complicated, but it may be simpler in actuality than the *chena* agriculture[7] of the Fang, with its varied migrations. Combinations of intensive agriculture and machine industry, characteristic of many parts of the Occidental world, account for the great

[2] Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C.

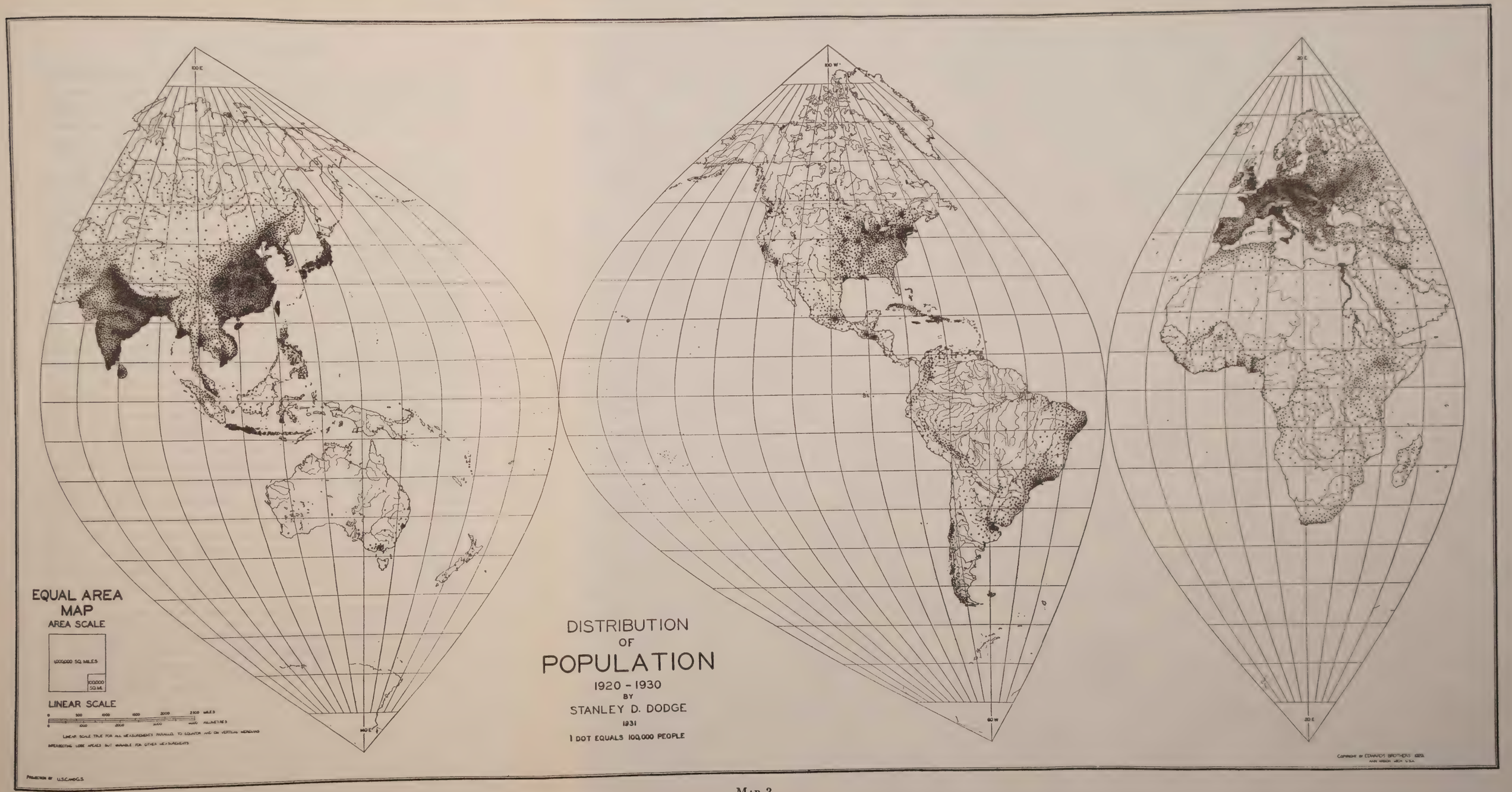
[3] "Russia: Territory and Population," *Geog. Rev.*, 18 (1928): 616–640.

[4] "Distribution of Population in China," *ibid.*, 15 (1925): 1–24.

[5] "Befolkningens fördelning på Gottland," *Ymer*, 28 (1908): 240–253.

[6] Brunhes, J., *La Géographie humaine* (Paris, 1925), pp. 471–491.

[7] *Chena* agriculture is a type found in the selva or tropical rain forest in which clearings are made by girdling and burning. The clearing is planted to the banana, beans, and other crops, which are allowed to grow almost unwatched. By the time a harvest is ready, the ground has become nearly unfit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OF
POPULATION
1920 - 1930
BY
STANLEY D. DODGE
1931
1 DOT EQUALS 100,000 PEOPLE
PROJECTION BY U.S.C.&G.S.
COPYRIGHT BY EDWARDS BROTHERS 1932
ANN ARBOR MICH. U.S.A.

MAP 3

agglomerations of people in western Europe and eastern North America, where agriculture is definitely associated with and fostered by industry. Cultivation of the soil provides food for industrial peoples in neighboring cities and also certain raw materials for industry itself.

The concentration of population in northwestern Europe, for example, could apparently be explained satisfactorily in terms of the coal and iron basis of the industries which seem to be the principal things in the area, but this is not true. There was a concentration of people in this now densely populated area of Europe prior to the discovery of the great importance of coal, prior to the development of the factory industrial system. From very early times the area above the mouth of the Rhine has been one of comparatively dense population. It is not industry alone, it is not agriculture alone that explains it; it is trade. The lands now comprised by the countries of Belgium and the Netherlands and by Westphalia have contained for many generations great centers of trading activity. In the Middle Ages these territories formed the junction of two frequented trade routes, the Rhine-Alps-Italy route and the Baltic-Russia route.[8] The trade flowing along these routes and the beginnings of manufacturing brought about an early concentration of people in the lower Rhine area.[9]

As trade developed, manufacturing, too, tended to develop somewhere on the trade routes, and that "somewhere" later on came to be especially those areas north of the Ardennes-Sauerland massifs, which were underlain with coal and which have today the principal concentrations of population.[10] This tendency is particularly well illustrated in Great Britain, where, with London as the center of commerce, people were formerly settled in greatest numbers in the Agricultural Lowland, stretching roughly from Swindon to Cambridge, and where today the concentration

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because of the growth of saplings and other weeds. After a few harvests, therefore, the ground is abandoned in favor of a new, more easily cleared tract.

[8] The Kiel Canal has made Hamburg the successor of Lübeck on this route.

[9] Pirenne, H., *Belgian Democracy* (Manchester, 1915), pp. 1–26, and *Medieval Cities* (Princeton, 1925), pp. 25–55, 78–108.

[10] See Fawcett, C. B., "The Balance of Urban and Rural Populations," *Geography*, 15 (1929): 99–106.

is largely on the coal fields of Wales, Lancashire, York, and the lowlands of Scotland.[11]

When we turn to the United States, which also has an "industry-plus-agriculture" genre de vie, the insignificance of coal and the importance of trade as the basis for a manufacturing concentration of population are even more clearly indicated. The principal coal fields of the eastern United States are in the northern Allegheny Plateau of Pennsylvania and West Virginia, and in Illinois, but the population there is less dense than it is in the area of great concentration which has its center on New York City, with a partly detached, secondary area about Boston. In addition, Chicago, Detroit, Cleveland, and St. Louis stand out as population centers, but none of them are on coal fields. They are, however, important trade foci, as are New York and Boston. It is true that coal has been used by, and has aided the industry of, these cities, but it is, apparently, the advantages of location with reference to trade that have stimulated growth of population in these several centers.[12]

Thus, in brief outline, have been sketched some of the major factors influencing the concentration of population in the principal areas of the Occidental world. Analysis suggests that more important than any single local resource in the localization of population groups is a complexity of geographic and non-geographic factors influencing trade.

The groups of dense population in eastern Asia are related to areas of more fertile soil in much the same way as those of western Europe are related to areas of coal. It is not the areas of fertile soil themselves which are of primary importance in the general distribution of population throughout the whole region, but rather the areas that are significant from the point of view of trade. Shanghai controls the trade area of the Yangtze-kiang, and Hankow has an almost ideal trade situation at the confluence of the Han-kiang and the Yangtze. Remote Chengtu, which would seem to be almost ideally independent of trade influences, is never-

[11] Mackinder, H. J., *Britain and the British Seas* (New York, 1902), pp. 329–340.

[12] Hartshorne, R., "Location Factors in the Iron and Steel Industry," *Econ. Geog.*, 4 (1928): 241–252.

theless located where routes emerge from the lofty plateau portions of western Sze-chuan.[13] In warm southern China the center of greatest density is Canton, which is located with respect to the trade advantages of the Si-kiang, though it is somewhat overshadowed in this respect by the British city of Victoria on the island of Hongkong.

Oriental populations, except in Japan, are apparently much less dependent on world trade than the foregoing statement would suggest. Though various important items of international trade originate among the farms of China, the population groups are nevertheless not wholly without a certain self-sufficiency. This is significant in connection with the vast numbers of people who are supported on an almost exclusively agricultural basis in many parts of the Orient. It may be presumed that the present low standards of living in China, for example, have been reached through a process of readjustment to increasing numbers of people for many generations, for these standards seem to be distinctly lower now than they were when Marco Polo visited the country in the thirteenth century. These large populations on an agricultural basis [14] are maintained, apparently, because of the system of diet to which the people have become adjusted. Rice, supplemented by leafy vegetables, such as Chinese cabbage, which is the principal diet of the well-settled parts of South China, the Philippines, Java, Bengal and Bihar, and Madras, makes an admirable diet for the maintenance of health.[15] The more densely settled areas of the Orient, therefore, are explainable in part, in contrast to the densely populated parts of the Occident, on the basis of the dietary régime which has been developed.

The amazing density of population in Java would seem to have developed as a result of a rather intensive plantation agriculture (*Plantagenbau*) under the influence of the Dutch, in addition to which it should be noted that the vegetable diet of the people is

[13] Hubbard, G. D., "The Geographic Setting of Chengtu," *Bull. Geog. Soc. Philadelphia*, 21 (1923): 109–139.

[14] See Roxby, *op. cit.*, and Mallory, W. H., *China: Land of Famine* (New York, 1926), pp. 13–20, 24–28.

[15] McCollum, E. V., "The Reaction of Food," in Cowdry, E. V., *Human Biology and Racial Welfare* (New York, 1930), pp. 340–341.

one that allows great density, because it involves an intensive use of the land. Such use is found in Egypt also, which is another remarkable isolated area of population density. Here the population is so nicely adjusted to the water supply that an increase of irrigation water sufficient to add ten dollars' worth of food to the yield of the land allows the increase of the whole number of inhabitants by one, and the reverse is also true.[16]

Throughout the larger part of the world, in contrast, the system of utilizing the land is extensive, though there are numerous local exceptions. A large area of land per person is necessary. Among the pastoral nomads of Asia and Africa, for example, where widely scattered grasses are garnered by cattle and converted by them to products used for human food, only a small number of people may be maintained per unit area. In such areas, however, local trade advantages may account for somewhat denser concentration of people, even in some cases for cities with numbers of inhabitants of about 500,000.[17]

The distribution of population, as the foregoing sketch indicates, is a geographical problem requiring for its solution the best powers of geographers, economists, biologists, historians, sociologists, and others. The geographical approach to the solving of this problem involves among other things an analysis of distribution patterns in detail for small sections of the surface of the earth. The question to be answered on the basis of such an analysis would be what kinds of land have been occupied and by what numbers of people. Details of site and situation would have to be investigated. The problem is complex and the answer may perpetually escape us, but at least part of it seems to involve localization with reference to trade advantages. Though this may help to solve the problem, it obviously also greatly complicates the situation, because of the extension of the sustenance area of local population groups in an intricate way.

University of Michigan

[16] Bowman, Isaiah, *The Pioneer Fringe* (New York, 1932), p. 43.

[17] Dodge, Stanley D., "The Distribution of Population in Northern Nigeria," *Pap. Mich. Acad. Sci., Arts and Letters*, 14 (1930): 297-303.

LEAD AND RAPID CITY

A STUDY OF CONTRASTING SETTLEMENTS WITHIN THE BLACK HILLS REGION

OTTO E. GUTHE

TWO distinctive types of settlement nuclei are found in the Black Hills region of western South Dakota and eastern Wyoming. The mining settlements, many of which are now abandoned, are seen clinging to the sides of remote valleys within the crystalline center of the maturely eroded dome (Map 4). These towns form the goals of penetrating lines of communication which connect them with the outside. Their locations are determined by the presence of accessible ore bodies. Proximity to the mine is of major importance, with the result that the sites of many are poor, and the situations have little or no value as a factor of location. The mine is the nucleus about which the economic functioning of these towns is oriented (Pl. VII, Fig. 1).

Agricultural settlements, which have taken upon themselves somewhat of the commercial function, are distributed along the outer border of the Black Hills region where natural focal points of routes exist (Map 4). Situation and site are important factors of location because of the very nature of the settlements. The functional nucleus of each town is the commercial area, but a complexity of economic orientation is present which is not found in a mining town (Pl. VII, Fig. 2).

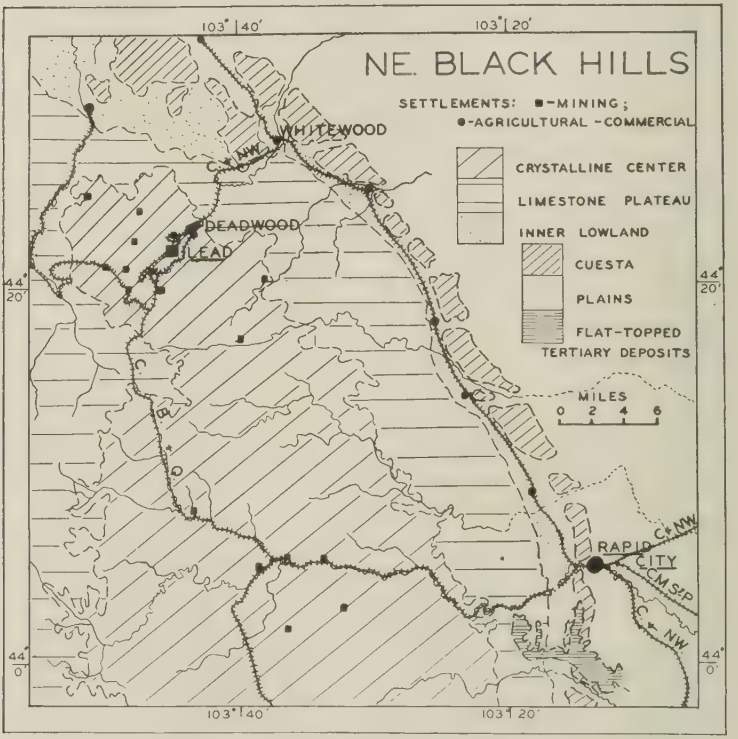
Lead and Rapid City illustrate these essential differences between the two types.

Lead

LOCATION AND GROWTH

The mining town of Lead lies three miles southwest of Deadwood, the earliest settlement in the northern Black Hills (Map 5),

and is 700 feet above it. It is approached by a difficult ascent up youthful valleys, which are cut 1,000 feet below the intervening mature ridges of crystalline rock (Pl. VIII, Fig. 1). Extending



Map 4. The northeastern Black Hills, with the distributions of the two types of settlement nuclei discussed

westward from Deadwood is the upper valley of Deadwood Creek, which is joined from the southwest by Whitewood Gulch. Gold Run, a tributary of Whitewood Creek, has cut a deep gorge through which an outlet is afforded for the drainage of its broader valley upstream. The immediate site of Lead is in the upper drainage

basin of this tributary, where the slopes are moderate and the valley is distinctly V-shaped.

The gold ore-bearing Homestake lode, which forms a portion of the intensely folded and compressed Pre-Cambrian rocks of the locality,[1] gave the first incentive to settlement. Rich strikes

Map 5. Surface configuration in the vicinity of Lead, showing the present urban limits of Lead and of the western portion of Deadwood

were made in 1875 in the placer deposits near the confluence of Deadwood and Whitewood creeks. The source of some quartz float was discovered in a ledge on the northern slope of Gold Run Valley by a miner. His claim attracted other miners from the lower valleys, and soon several log cabins were erected on the present site of Lead. Mining operations began, mills were erected,

[1] Connolly, J. P., and O'Harra, C. C., "The Mineral Wealth of the Black Hills," *Bull. 16*, p. 77 (South Dakota School of Mines, 1929).

and many claims were being worked separately. But, as time went on, the Homestake Mining Company consolidated with all these holdings, until at present it is owner of practically all mining property in the vicinity, a total of 557 lode claims.[2] It is the presence of this company within Lead which has led to its rapid and nearly continuous growth.

There is an expected correlation between the increase in population of Lead and the demand for labor in the mining operations, since approximately 60 per cent of the male population is employed in mining and much of the remaining population is made up of the dependents of the miners. The early growth of Lead, based on lode mining, was more steady than that of placer-mining towns. In 1880 its population was 1,437 (Table I). By 1890 it had increased by nearly 80 per cent; it continued its growth until 1914, when an estimate of 9,321 inhabitants was made.[3] This advance came during the period of expansion of operations and consolidation of properties by the Homestake Mine from 1890 to 1910. During the World War and the adjustment period following, improved methods of mining were worked out, which greatly reduced the handling of the ore. It was a period of mechanization and concentration of activities.

TABLE I

POPULATION STATISTICS

Year	*Lead*	*Rapid City*
1880	1,437	292
1890	2,581	2,128
1900	6,219	1,342
1910	8,392	3,845
1920	5,013	5,777
1930	5,773	10,404

[2] For an historical sketch of the Homestake Mine, see *ibid.*, pp. 73–76. Also Yates, B. C., "The Homestake Mine," *The Black Hills Engineer*, 14 (1926): 131–139.

[3] *Census of the United States*, Nos. 11–15, United States Department of Commerce, Bureau of the Census.

TRANSPORTATION

Because of its unfavorable situation Lead forms the end of routes tributary to the main line of communication. Its more accessible neighbor, Deadwood, is the natural focus within the northern Black Hills, since it is located at the junction of several valleys which act as highways (Map 5). There were two chief routes into this region. Supplies were brought from Bismarck or Fort Pierre across the plains into Deadwood from the east, or from Cheyenne through the Hills from the south, entering Deadwood from Strawberry Gulch. Lead was reached by an indirect route from Deadwood by way of the valley of Deadwood Creek and up Poorman Gulch, since the gorge of Gold Run was impassable.[4] At the time of the foundation of Lead this route was used exclusively, and it was not until later that a more direct route was laid out.

A period of rapid railroad construction followed. At present the Chicago and Northwestern Railroad has extended a line from Whitewood through Deadwood to its terminus in the eastern part of Lead, and the Chicago, Burlington, and Quincy Railroad has run a line northward through the Hills from Nebraska, entering Lead from the west at a higher elevation (Map 4). Well-graded roads have now opened the town to truck and bus service.[5]

GROWTH OF THE STREET PATTERN

The street pattern of Lead is irregular, molded by surface configuration and characterized by narrow, inadequate roads (Pl. VIII, Fig. 2). The original town was laid out on the northern slope of the valley near the first mine. Main Street and two others conformed to the axis of the valley, which extends roughly in an east–west direction; the remaining six streets followed the direction of slope, crossing the former at right angles (Map 6). Shortly after the original settlement had been established, another

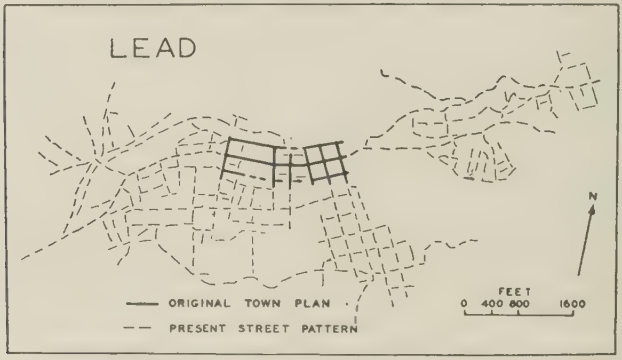
[4] Raddick, W. P., "Historic Record of Lead," *Lead Daily Call*, August 5, 1926, p. 17.

[5] For details of railroad development in South Dakota see the *Annual Reports of the Board of Railroad Commissioners, State of South Dakota.*

grew up less than a mile to the east, but was later incorporated with Lead.[6] Irregularity has prevailed in the subsequent development; the pattern varies with the character of the surface and with the ideas of the individual promotors. Low saddles have made possible expansion to the southeast and west.

DISTRIBUTION OF FUNCTIONAL AREAS

The primary function of the town is embodied in the activities of the Homestake Mining Company, whereas the commercial function is distinctly subordinate. Other industries of importance



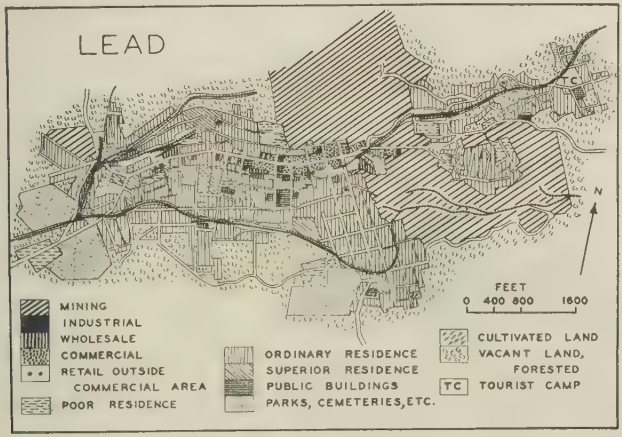
Map 6. Original street pattern of Lead

are lacking. The functional nucleus of the town, which consists of the mine and associated buildings, is spread over a considerable area; its location is determined by the position of the Homestake lode, from which the ore is obtained (Map 7). Hoists bring the ore to the surface, and it is transported to the mills by tram. Mills, hoists, and shops are connected by track and covered runways, with the more modern buildings occupying the slope to the southeast. To the north of the original town is seen the huge open cut. It is slowly encroaching upon the commercial area, a reflection of the subordinate position of commerce to mining (Pl. IX, Fig. 1).

The commercial area became localized within a part of the

[6] Raddick, *op. cit.*, p. 17.

original town and has expanded westward along both sides of Main Street (Pl. IX, Fig. 2). The relationship between the distribution of railroad property and the commercial and wholesale areas is evidenced by the locations of the stations at points most accessible to these districts. The Chicago, Burlington, and Quincy Railroad enters by a saddle from the west, where it divides, with one track following the northern slope and the other the southern slope to the mine. The Chicago and Northwestern first



Map 7. Distribution of functional areas within Lead

attains the level of the valley bottom at the eastern end of the commercial area.

The complexity of the residential distributions harmonizes with the irregularity of the street pattern. No degree of zoning is apparent, since superior residences lie adjacent to, or surrounded by, poor districts (Pl. X, Fig. 1). There is, however, a noticeable concentration of poor residences close to the mining property and to the commercial area.

The urban scene of Lead is more complex than that of most mining towns of the Black Hills, but embodies within it various phenomena which may occur in simpler arrangement in smaller nuclei.

Rapid City

location and growth

Rapid City, in direct contrast to Lead, is a commercial center, located on the outer border of the Black Hills and forming a focus upon which routes converge. The advantages of its site and situation have aided in its development. It is a trade center for the entire Black Hills, and its situation is significant because of its proximity to the population centers of eastern United States.

From the wooded limestone plateau to the west one can discern clearly the chief features of the surface configuration which characterize the margin of the Black Hills (Map 4). The immediate slope, deeply cut by the few major streams which flow to the plains, is covered with a scattered growth of pine, which finds a foothold on the nearly barren rock surfaces. At the base of the slope an inner lowland extends in a northwest–southeast direction and is grass-covered, except where cottonwoods and oak mark the courses of the eastward-flowing streams. To the south this lowland is interrupted by high, flat-topped hills; to the east the well-defined escarpment of a cuesta, which forms the eastern boundary of the Black Hills, rises from 300 to 500 feet above the lowland. A growth of scrubby pine covers the upper slopes. The continuity of this cuesta is broken by a series of water gaps. Beyond the cuesta extends the wide expanse of grassy plains; the flood plains of the streams lie 300 feet below the general level. The site of Rapid City is just at the outer edge of the cuesta in the broad valley of Rapid Creek. The immediate flood plain and extensive low terraces are bounded on the north and northeast by terraces of intermediate height, and on the south by two remnants of high terraces. The back slope of the cuesta occurs to the west, steeply rising on each side of the gap through which Rapid Creek escapes from the inner lowland (Map 8).

The advantages of this site and situation are several. A water gap which gives ready access to the Hills and to the nearly level inner lowland extending northwestward (Pl. X, Fig. 2), the proximity of this point to eastern United States, and the presence

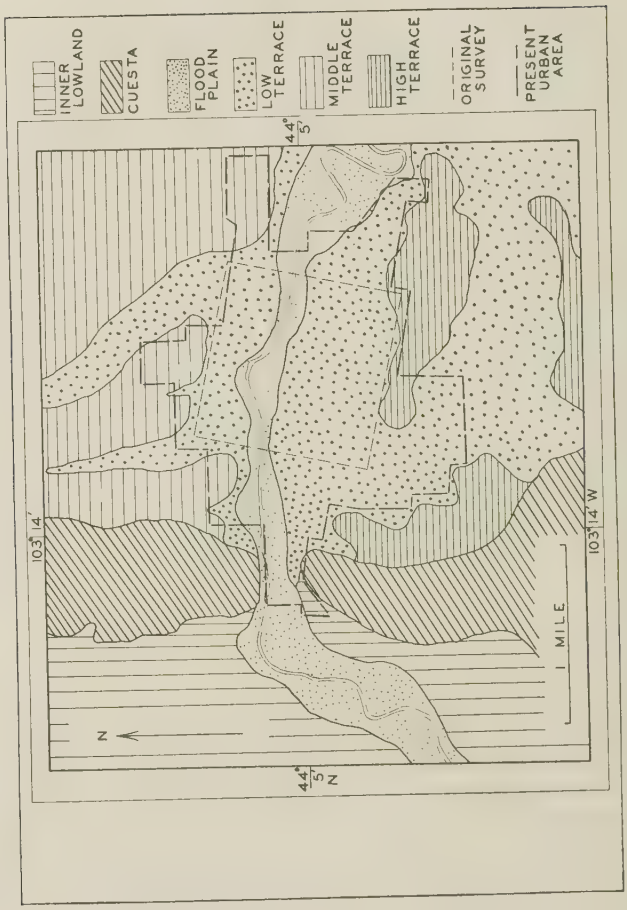
of the full-flowing Rapid Creek for a water supply are factors which partly explain Rapid City's dominance in the region.

Contrary to most instances of town development, the site of Rapid City was selected and its future growth planned at a time when the surrounding country was entirely undeveloped. A group of men who had been mining in the Hills were impressed by the agricultural possibilities of the broad valley and in February, 1876, laid out the town. Early development was characterized by an intensive campaign of propaganda to promote town growth. Persuasive methods were used and inducements offered to potential settlers.[7] The town, as a result, gained quickly in population. In 1880 it had only 292 inhabitants; by 1890 there had occurred an increase to 2,129. The 1900 census showed a marked decrease, due probably to two successive seasons of crop failure and drought in the last years of the nineteenth century. But the establishment of railroad connections between 1900 and 1910 caused Rapid City to become the railroad center of western South Dakota. By 1910 the population had increased over that of 1900 by 187 per cent and it is still advancing (Table I). The automobile has added a new element, "tourism," a factor influential in recent development. The location of the city at the natural gateway to the Hills on the most traveled highway of western South Dakota, coupled with the potentialities of scenic exploitation and an active chamber of commerce, are an effective combination.

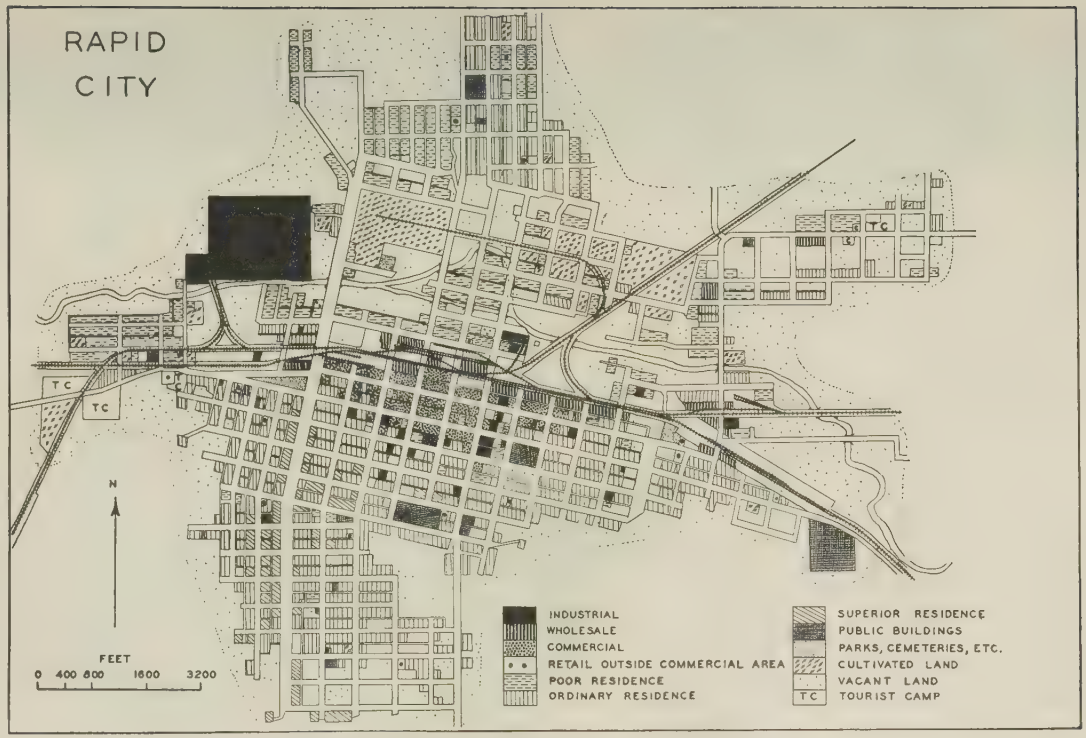
TRANSPORTATION

Rapid City is the point upon which routes of communication converge. Immediately upon the establishment of the settlement wagon roads were laid out to Pierre in the east and westward into the Hills, thus establishing the preëminence of this water gap. The owners of the stage line from Sidney to Deadwood took advantage of the shorter, more level route through Rapid City, instead of continuing on the former road through Custer. The first railway entered the city in 1886, running from Omaha to the northern Hills. Early in 1907 the Chicago and Northwestern

[7] Brennan, J. R., "Rapid City's Beginning," *Rapid City Daily Journal* (Holiday Greetings), 1919–20, pp. 3–4.



Map 8. Surface configuration of the site of Rapid City



Map 9. Distribution of functional areas within Rapid City

Railroad completed a line connecting Pierre with Rapid City. In the same year the Chicago, Milwaukee, and St. Paul extension entered the city from the east. All rail and highway traffic reaching the Hills from the east passes through this point (Map 4).

GROWTH OF THE STREET PATTERN

The street pattern of Rapid City is distinctly rectangular and is characterized by broad streets and regularity of planning. The north-south, east west arrangement is adhered to only in the outer portions of the city, whereas the central part is oriented at a decided angle. This discontinuity is the result of the original survey of the town site by the founders, who measured out a section by pacing and compass, uncorrected for declination (Map 8). Six blocks in the center of this section formed the original town,[8] from which center expansion proceeded, primarily to the south. To the north and east the poorly drained flood plain hindered expansion. At present this hindrance has been partly overcome, and the intermediate terraces to the north are being built up. The high terraces to the south have been avoided because of the increased exposure to the hot winds of this semi-arid region. The city lies protected in the valley, invisible from the general level of the plains.

DISTRIBUTION OF FUNCTIONAL AREAS

Rapid City exhibits the development of several independent functions (Map 9). Of outstanding importance is the commercial function.[9] The industrial function is embodied in several manufacturing concerns, and tourism is reflected by the number of tourist camps. Three factors of influence in determining the distribution of functional areas within the city are surface configuration, drainage, and the position of the original settlement.

The commercial area, which is oriented in an east-west direction parallel to traffic lines, has expanded southward, avoiding

[8] Scott, Samuel, "Rapid City's Beginning," *Rapid City Daily Journal* (Holiday Greetings), 1919–20, p. 7.

[9] For statistics of the retail trade of Rapid City see the preliminary report of the *Fifteenth Census, Census of Distribution, Retail Distribution in the United States*, United States Department of Commerce, Bureau of the Census.

FIG. 1. Abandoned mining town of Trojan, typical of many in the crystalline center of the northern Black Hills

FIG. 2. The small commercial town of Whitewood on the outer border of the Black Hills

PLATE VIII

FIG. 1. A valley near Lead. Note the lines of communication in the valley bottom

FIG. 2. A characteristic street in the residential section of Lead

FIG. 1. An aërial view of Lead, looking south. The huge open cut in the foreground encroaches upon the commercial area. The many buildings of the Homestake Mine are to the left of the open cut

FIG. 2. Main Street, Lead. A part of the commercial area

FIG. 1. A part of the residential area of Lead. The commercial core is in the foreground

FIG. 2. Rapid City, looking northwest. The commercial area is in the center. The water gap in the cuesta, the inner lowland, and the limestone plateau may be seen in the background

Photograph by Rise

FIG. 1. Rapid City, looking northeast. In order from foreground to background: the commercial area, the poor residences and vacant land of the immediate flood plain, the residential district on the intermediate terraces, and the semi-arid plains

Photograph by Rise

FIG. 2. Rapid City, looking east. Note high terraces on extreme left

the flood plain. The distribution of railroad property results from the expected convergence upon the commercial area and the gap, and has partly hindered northward expansion. Cheap land and proximity to transportation have caused a concentration of industrial activities on the flood plain. Much of this lower area is vacant or in truck gardens, or is occupied by the majority of poor residential districts. The older and better residential areas have expanded southward, but a recent increase in ordinary dwellings has taken place on the less suitable intermediate terraces north of the flood plain (Pl. XI, Figs. 1–2).

Conclusion

The urban landscapes of Lead and Rapid City differ as a result of contrasting situations, sites, and dominant functions. Lead is a town poorly situated in respect to commerce, isolated by surface conditions. Its site has caused a concentration of growth and a molding of the patterns of its functional structure to the configuration of the surface. The one reason for its existence and growth has been its functional dependence upon the Homestake Mine.

Rapid City, however, is strategically situated at a focus of communication between the population centers of eastern United States and the Black Hills. The site has allowed expansion in many directions, and the surface configuration has played a comparatively passive rôle in influencing the patterns of functional distributions. The situation of the city has determined to a great degree the dominating function, although other functions have developed, based upon the resources of the surrounding areas.

University of Michigan

LANDFORMS OF JAPAN

ROBERT BURNETT HALL * AND AKIRA WATANABE †

THE Japanese Archipelago bears many interesting geotectonic relationships. It early attracted the attention of geologists and geographers, and a number of important contributions were published on the tectonic structure and relationships of these islands. In most investigations considerable attention was paid to landforms as well.[1] In 1917 Professor H. Yabe [2] made a critical review of these early works. He pointed out their contradictions and errors as revealed by the large accumulation of later studies. In 1914 Professor B. Koto wrote "A Morphological Summary of Japan and Korea," [3] and between 1903 and 1915 Professors N. Yamasaki and D. Sato published their ten-volume work on *The Regional Geography of Japan*.[4] To date these constitute the most extensive and valuable contributions on the landforms of Japan. In the last few years many contributions have been made to the geomorphology of specific regions and to general

* Fellow of the Social Science Research Council, 1929, and recipient of a grant-in-aid of the Social Science Research Council, 1931, for research in geography in the Japanese Empire.

† Fellow in geography, University of Michigan, 1930 and 1931; field assistant in both projects mentioned above; at present on the faculty of the Geographical Institute, Tokyo Imperial University.

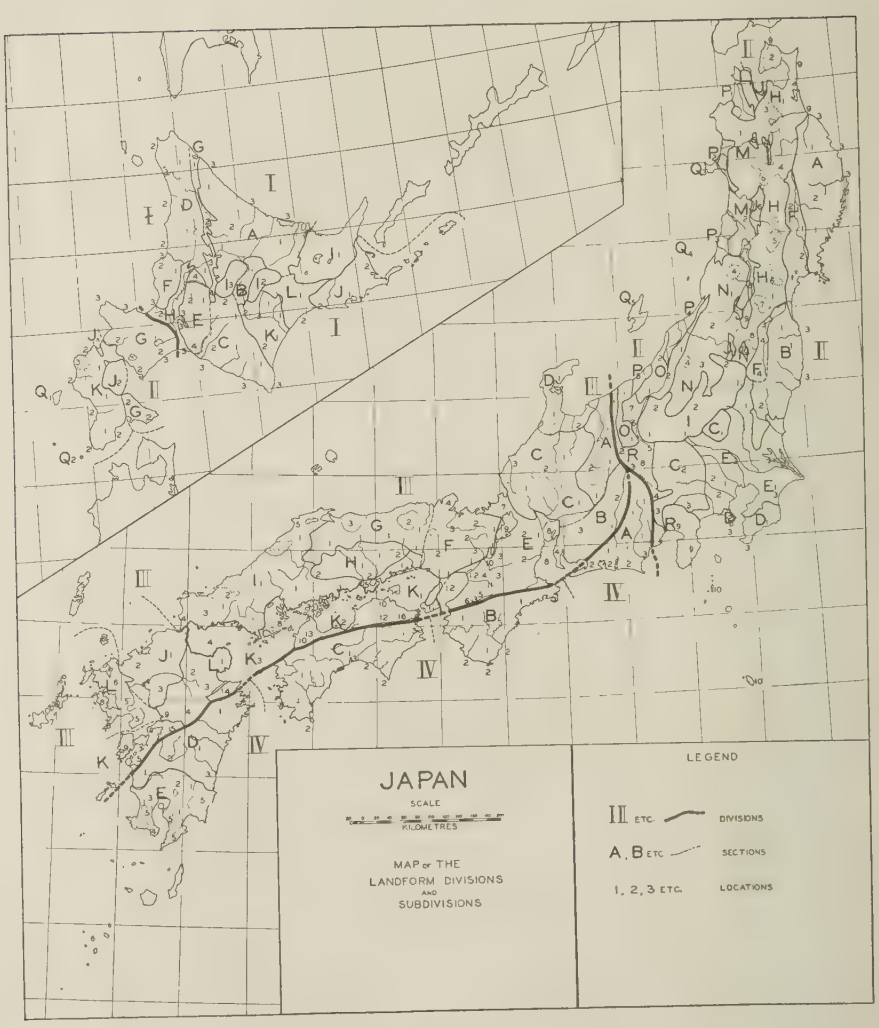
NOTE — All articles cited are in Japanese except those in notes 29, 32 (second title), 35, 43, 57 (second title), 67, 91, 99, 107.

[1] Among the more important of the early contributions should be mentioned those of E. Naumann, T. Harada, E. Suess, T. Ogawa, F. Richtofen, and B. Koto.

[2] *Sci. Rep. Tohoku Imper. Univ., Ind. Ser.* (Geology), 4 (1917) : 76–104.

[3] *Journ. Geol. Soc. of Tokyo*, 21 (1914) : 115–126, 147–157, 163–176.

[4] Yamasaki, N., and Sato, T., *The Regional Geography of Japan*. 10 vols., published between 1903 and 1915. Tokyo.


JAPAN
SCALE
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LANDFORM DIVISIONS
AND
SUBDIVISIONS
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III ETC. DIVISIONS
A, B ETC. SECTIONS
1, 2, 3 ETC. LOCATIONS

Map 10

morphological problems.[5] For the first time it is now possible to give a complete general description of the landforms of Japan.

The object of this paper is to present an outline of the landforms of "Old Japan" and Hokkaido,[6] an area in which both writers have traveled widely and have prosecuted some field studies. The accumulated literature, however, constitutes the principal source of data used. The detailed topographic sheets on a scale of 1:50,000 and the geological maps on a scale of 1:200,000 have been constantly employed; in the several localities of which the literature is poor, or entirely lacking, they have proved to be invaluable aids.

As is to be expected in Japan, a close correlation is usually found between the geotectonic structure and the present surface form. In areas where such correlation does not exist, as, for example, in central Kyushu, morphologic boundaries are chosen in determining divisions. In each area the morphologic character of the division and the nature of the boundary lines will be discussed. The major divisions, subdivisions, and sections to be discussed are as follows (see Map 10):

LANDFORMS OF JAPAN

I. Hokkaido Proper
- A. Kitami mountain land
  1. Subdued mountains
  2. Uenshiri horst
  3. Marine terraces
- B. Ishikari mountain land
  1. Erosion remnants
  2. Erosion levels
- C. Hidaka mountain land
  1. Maturely dissected mountains
  2. Subdued mountains
  3. Marine terraces
- D. Teshio mountain land
  1. Subdued mountains
  2. Marine terraces
  3. Littoral lowland

[5] Particularly significant among the more recent works are: Tsujimura, T., *The Regional Physiography of Japan* (Tokyo, 1929), and Shimomura, H., "Physiographic Provinces of Japan," *Geog. Rev. of Japan*, 2 (1926) : 1027–1039; 3 (1927) : 327–335, 863–873. These studies pertain entirely to southwestern Japan, in spite of their more ambitious titles; upon these the present authors have relied frequently in their treatment of southwestern Japan.

[6] In the spelling of all place-names the Anglicized forms have been used instead of the Japanese Romaji, which appears on some government geological and other maps. All elevations have been checked with the government topographic sheets on a scale of 1 : 50,000.

I. Hokkaido Proper (*cont.*)
- E. Yubari mountain land
  1. Ashibetsu tilted block
  2. Bibae tilted block
  3. Southwestern tilted block
  4. Southern low-relief area
- F. Mashike mountain land
  1. Maturely dissected mountains
  2. Mashike lava plateau
  3. Marine terraces
- G. Central lowland
  1. Tombetsu depression
  2. Nayoro Basin
  3. Kamikawa Basin
  4. Furano Basin
- H. Ishikari-Yufutsu lowland
  1. Ishikari graben
  2. Ishikari lowland
  3. Volcanic ash upland
- I. Eastern volcanic region
  1. Kutsharo volcanic group
  2. Shikaribetsu volcanic group
  3. Tokachi volcanic group
- J. Nemuro upland
  1. Abraded upland
  2. Valley lowland
- K. Tokachi coastal plain
  1. Coastal plain
  2. Alluvial fans
  3. Flood plains
- L. Shira-nuka Hills
  1. Shira-nuka Hills
  2. Marine terraces

II. Northeastern Japan
- A. Kitakami mountain land
  1. Elevated peneplain
  2. Monadnocks
  3. Marine terraces
- B. Abukuma mountain land
  1. Elevated peneplain
  2. Maturely dissected mountains
  3. Marine terraces
- C. Kwanto mountain land
  1. Ashio mountain mass
  2. Chichibu mountain mass
  3. Tanzawa mountain mass
- D. Boso and Miura peninsulas
  1. Boso Peninsula
  2. Miura Peninsula
  3. Marine terraces
- E. Kwanto coastal plain
  1. Coastal plain
  2. Older coastal plains
  3. Flood plains
- F. Kitakami-Abukuma lowland
  1. Dissected erosion level in Kitakami lowland
  2. Alluvial fans
  3. Fukushima graben
  4. Dissected erosion levels in Abukuma lowland
- G. Western volcanic region of Hokkaido
  1. Volcanic plateau
  2. Volcanic cones
  3. Marine terraces
- H. Central range
  1. Backbone range
  2. Osore-yama volcanic group
  3. Hakkoda-san volcanic group
  4. Ganshu-san volcanic group
  5. Sugawa-dake volcanic group
  6. Funagata-yama volcanic group
  7. Zao-san volcanic group
  8. Bandai-san volcanic group
  9. Marine terraces

II. Northeastern Japan (*cont.*)

I. Volcanic region of central Honshu
1. Young volcanic cones
2. Dissected volcanic cones

J. Central basins
1. Suttsu Bay
2. Volcano Bay
3. Mutsu Bay
4. Hanawa Basin
5. Odate Basin
6. Yokote Basin
7. Shinjo Basin
8. Yamagata Basin
9. Yonezawa Basin
10. Inawashiro Basin
11. Aizu Basin

K. Oshima mountain land
1. Maturely dissected mountains
2. Marine terraces
3. Kariba-yama volcano

L. Tsugaru horst
1. Tsugaru horst

M. Dewa Hills
1. Maturely dissected mountains
2. Youthful hills

N. Asahi-Iitoyo mountain land
1. Asahi mountain mass
2. Iitoyo mountain mass
3. Echigo mountain mass
4. Dissected volcanoes

O. Block mountains of Echigo
1. Mountain ranges
2. Longitudinal valleys

P. The delta plains of the Sea of Japan
1. Tsugaru Plain
2. Noshiro Plain
3. Shonai Plain
4. Echigo Plain
5. Takata Plain

Q. Islands of the Sea of Japan
1. Okushiri Island
2. Volcanic islands of Oshima and Koshima
3. Oga Peninsula
4. Awashima and Tobishima
5. Sado Island

R. Transversal lowland
1. Himekawa depression
2. Matsumoto Basin
3. Suwa Basin
4. Kofu Basin
5. Saku Daira
6. Zenkoji Daira
7. Myoko volcanic group
8. Yatsugatake volcanic group
9. Fuji-Amagi volcanic group
10. Shichito Maliauna volcanic islands

III. Inner Zone of Southwestern Japan

A. Hida mountain land
1. Maturely dissected mountains
2. Hida volcanic group

B. Kiso mountain land
1. Maturely dissected mountains
2. Ina Basin
3. Elevated peneplain of Mikawa
4. Chita Peninsula

C. Central Plateau
1. Maturely dissected plateau
2. Hakusan volcanic group
3. Kaga Plain

D. Noto Peninsula
1. Peninsula proper
2. Toyama Plain

III. Inner Zone of Southwestern Japan (*cont.*)

E. Block mountains and fault depressions of Kinki district
1. Yoro tilted block
2. Suzuka horst
3. Kasagi block
4. Ikoma tilted block
5. Kongo horst
6. Izumi horst
7. Broken mountain lands
8. Ise Bay and Nobi Plain
9. Omi Basin
10. Yamashiro Basin
11. Yamato Basin
12. Osaka Bay and Settsu Plain
13. Kinokawa graben

F. Tamba Plateau
1. Marginal horsts
2. Maturely dissected plateau
3. Waste-filled basins
4. Tango Peninsula

G. Eastern Chugoku mountain land
1. Maturely dissected mountain
2. Hyonosen volcanic group
3. Daisen volcanic group

H. Kibi Plateau
1. Elevated peneplain
2. Maturely dissected peneplain

I. Western Chugoku mountain land
1. Block mountains and fault valleys
2. Western volcanic groups
3. Akiyoshidai Karst plateau
4. Western subdued locality
5. Izumo Plain

J. Block mountains and fault depressions of northern Kyushu
1. Chikuho block mountains
2. Seburu horst
3. Southern block mountains
4. Tsukushi Plain
5. Tsushima Island

K. Setouchi Depression
1. Harima-nada
2. Bingo-nada
3. Iyo-nada
4. Suwo-nada
5. Yatsushiro Sea
6. Shiwaku Island group
7. Omi Islands group
8. Kurahashi Island; group localities
9. Amakusa Island group
10. Delta plains
11. Yzuru horst
12. Sanuki horst
13. Takanawa Peninsula
14. Yoroigatake block
15. Udo Peninsula
16. Yoshinogawa graben

L. Volcanic region of central Kyushu
1. Kunisaki Peninsula
2. Yabakei lava plateau
3. Kujyu volcanic group
4. Aso volcano
5. Kimpo, Tara and Unzen volcanoes
6. Broken basaltic plateau
7. Goto Islands
8. Crystalline rock area
9. Kumamoto Plain

IV. Outer Zone of Southwestern Japan

A. Akaishi mountain land
1. Maturely dissected mountains

IV. Outer Zone of Southwestern Japan (*cont.*)
- A. Akaishi mountain land
  - 2. Tertiary hills and elevated deltas
  - 3. Delta plains
- B. Kii mountain land
  - 1. Maturely dissected mountains
  - 2. Marine terraces
- C. Shikoku mountain land
  - 1. Maturely dissected mountains
  - 2. Marine terraces
  - 3. Delta plains
- D. Kyushu mountain land
  - 1. Maturely dissected mountains
  - 2. Hitoyoshi Basin
  - 3. Sadowara coastal plain
- E. Volcanic region of southwestern Kyushu
  - 1. Volcanic plateau
  - 2. Kirishima volcanic group
  - 3. Sakurajima volcanic group
  - 4. Kaimon volcanic group
  - 5. Mesozoic and granitic prominences
  - 6. Ryukyu volcanic islands

I. HOKKAIDO PROPER

The Hokkaido Proper division includes the main body of Hokkaido Island, which lies north of the Ishikari-Yufutsu lowland (Map 10, I, H). Its chief distinguishing characteristics are: (1) a subdued mountain topography; (2) a series of volcanic mountains arranged *en échelon;* and (3) the most extensive development of marine terraces found anywhere in Japan. This area is regarded as a major morphologic division, although it is made up of several strikingly different features. Two mountain systems, which constitute the backbone of the island, extend meridionally from Cape Soya to Cape Erimo and inclose a series of fault basins. The easternmost system is the loftier; both tend to increase in elevation from north to south.[7] The circum-Pacific "ring of fire" is represented in this division by a row of volcanic mountains, which penetrate from the Shiretoko Peninsula in the east to the center of the island. The highest elevations in Hokkaido are found in

[7] The Kitami mountain land, which forms the northern part of the eastern system, has a general elevation of about 1,000 meters, and a maximum elevation of 1,585 meters in Teshio-dake. In the Ishikari mountain land just to the south many peaks exceed 1,800 meters; Ishikari-dake reaches 1,980 meters. Farther south, several peaks of the Hidaka mountain land are more than 2,000 meters in elevation. The western system is less lofty. Only two of the peaks in the Teshio mountain land exceed 1,000 meters; the maximum elevation is 1,032 meters. In the Yubari area several peaks exceed 1,300 meters, and Mt. Ashibetsu reaches 1,727 meters.

these peaks. In the southeast is the spacious coastal plain of Tokachi.

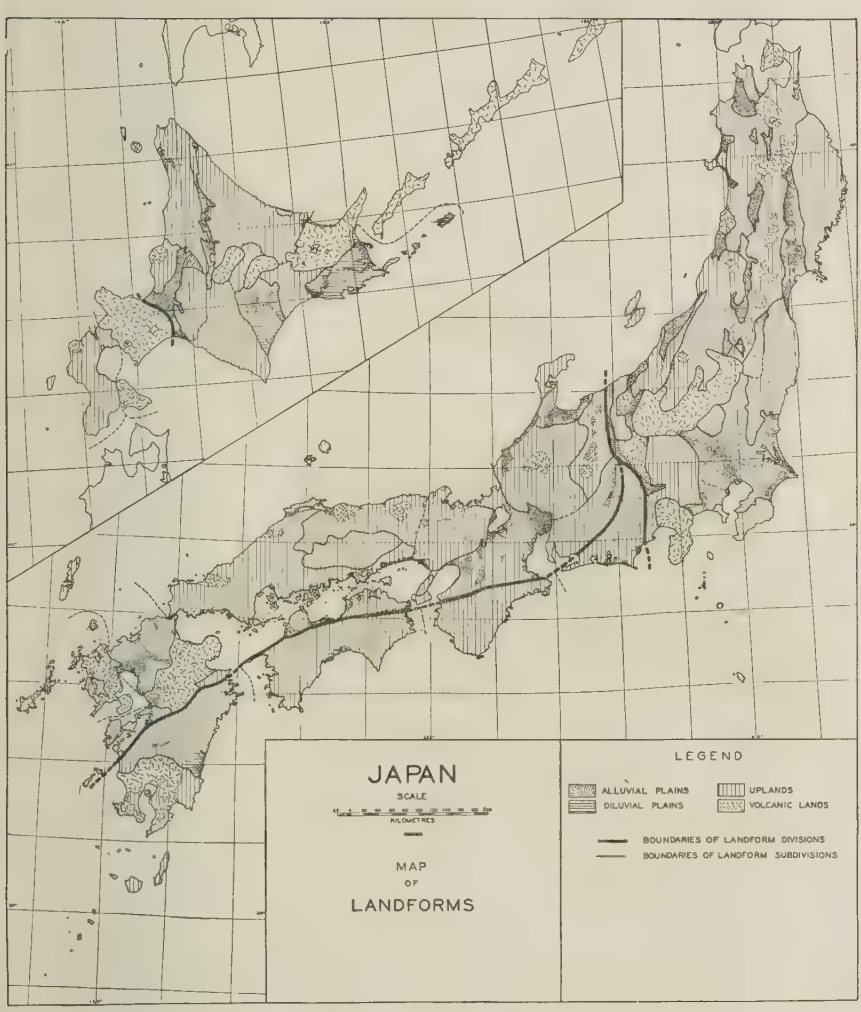
Each of the meridional mountain masses is divided into more or less independent mountain lands by low gaps or by gorges. In general, each mountain land may be regarded as a warped dome, the margins of which not infrequently have been dropped by faulting. Conspicuous granitic cores are exposed in the main ridges of the Hidaka and Ishikari mountain lands (Map 11). Volcanic rocks are widely distributed throughout the mountain lands of Kitami and Teshio. The accompanying fault scarps are all more or less meridional and most of them occur on the inner margins, thus embracing the central fault basins. In the extreme north and south these fault scarps are replaced by flexure scarps.

Flat-topped crests can be found in all of the mountain lands. It is probable that these surfaces do not indicate the existence of a once extensive peneplain, but rather represent several levels which have been formed in the course of successive uplifts. The Kitami and Teshio mountain lands are distinctly of subdued forms that present no steep slopes or sharp ridges. The three southern mountain lands are of stronger relief and, in many places, are characterized by sharp ridges and steep valley walls.

The volcanic mountains occur in three separate clusters which are called, from east to west, the Kutsharo, the Shikaribetsu, and the Tokachi volcanic groups.

A salient feature of Hokkaido is the unusual development of marine terraces. In width, continuity, and extent they have no equal in Japan. Most of them are abrasion surfaces capped with a thin veneer of beach gravels, and display distinct sea cliffs at their rear. Many of them are multicycled in origin and their descent to the present shore line is by several minor steps. The highest marine terrace so far identified in Hokkaido is at Cape Erimo, where an elevation of 320 meters is attained. Their height in each locality is shown just offshore on Map 12.

A. The Kitami mountain land occupies the north-central portion of Hokkaido. As a whole, it is a typical upwarped block, except that its western boundary is dropped to the central low-


JAPAN
SCALE
KILOMETRES
MAP
OF
LANDFORMS
LEGEND
ALLUVIAL PLAINS
DILUVIAL PLAINS
UPLANDS
VOLCANIC LANDS
BOUNDARIES OF LANDFORM DIVISIONS
BOUNDARIES OF LANDFORM SUBDIVISIONS

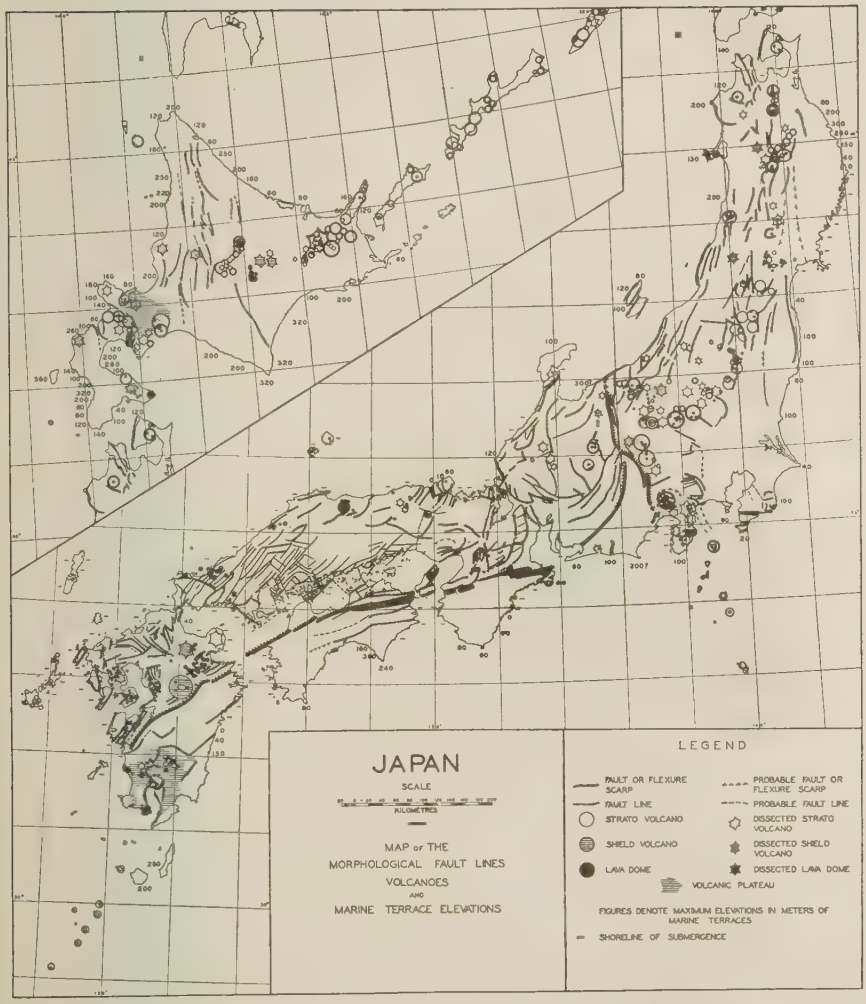
Map 11

land by marginal fault and flexure. In the south-central part the conspicuous Uenshiri horst rises above the surrounding area. Many of its peaks exceed 1,000 meters; Teshio-dake reaches 1,585 meters. The highest elevations occur in its southern extension. The peaks in other parts of the Kitami mountain land are usually between 750 and 950 meters above sea level.

This subdivision, in general, is a subdued mountain land and is characterized by coarse-textured slopes of gentle concave declivity. There are many erosion-surface levels which mark successive steps of uplift. The highest level of this type occurs near the summit of Mount Teshio. Along the shore of the Sea of Okhotsk there are several steps of marine terrace. The lowest one is so nearly at sea level that it is virtually impossible to tell where the terrace ends and where the erosion surface of subaërial origin begins.

B. The Ishikari mountain land lies immediately south of the subdivision just discussed and is wedged in between the Shikaribetsu and Tokachi volcanic groups. It is a maturely dissected mountain area of strong relief, composed chiefly of Paleozoic rocks, although the crest of the highest peak, Ishikari-dake (1,980 meters), is granitic. All the prominent peaks exceed 1,600 meters in elevation. The Ishikari mountain land, which is believed to be a huge erosion remnant (*unaka*), rises above the adjacent 1,000-meter level. Wide erosion valleys penetrate deeply into it from the margins.

C. The Hidaka mountain land attains the greatest elevations found in Hokkaido except in the volcanic peaks. It is a huge tilted block. The front faces to the east and the back slope gradually gives way to the southwest. The eastern margin is marked by a bold fault scarp of more than 1,500 meters. The northern half of this escarpment is maturely dissected, but the southern half gradually changes to a flexure scarp. At the foot of the scarp an extensive development of composite alluvial fans occurs. The back slope is long and gradual and is maturely dissected, so that the occurrence and extent of flat-topped crests are very limited. The important streams of this area are consequent to the inclination of this back slope and their length is thus


JAPAN
SCALE
KILOMETRES
MAP OF THE
MORPHOLOGICAL FAULT LINES
VOLCANOES
AND
MARINE TERRACE ELEVATIONS
LEGEND
FAULT OR FLEXURE SCARP
FAULT LINE
STRATO VOLCANO
SHIELD VOLCANO
LAVA DOME
PROBABLE FAULT OR FLEXURE SCARP
PROBABLE FAULT LINE
DISSECTED STRATO VOLCANO
DISSECTED SHIELD VOLCANO
DISSECTED LAVA DOME
VOLCANIC PLATEAU
FIGURES DENOTE MAXIMUM ELEVATIONS IN METERS OF MARINE TERRACES
SHORELINE OF SUBMERGENCE

Map 12

determined. Near the center of the granitic backbone, which marks the top of the escarpment, occur the highest elevations. Poroshiri-dake reaches 2,052 meters. It is from this location that cirque remnants have been reported.[8] Northward and southward from this point there is a general decrease in elevation. On the northern margin this area is separated from the Ishikari mountain land by a low saddle known as the Karikachi Pass (Pl. XII, Fig. 1). In this vicinity the general level is about 1,000 meters, and the surface is characterized by gently rounded slopes with widely spaced streams.

The seaward margin of this subdivision is skirted by marine terraces, most of which are multicycled and present high and conspicuous sea cliffs at their backs. At the foot of the innermost cliff an elevation of about 200 meters is maintained for the entire extent of the coast. At the southern tip of Cape Erimo an abrasion surface of 320 meters occurs. The combined breadth of these terraces has a maximum width of 15 kilometers.

D. The Teshio mountain land, like the Kitami section, just to the east, is a typical upwarped block characterized by subdued topography. A group of peaks near the center contains the only ones exceeding 800 meters. The entire eastern edge is marked by marginal fault scarps which tower above the central lowland. Other fault scarps cut the interior of the area. The rivers Teshio and Ishikari, after draining considerable areas of the central lowland, flow through the Teshio mountain land in antecedent gorges. Extensive remnants of several erosion levels are found. The highest one is interrupted at frequent intervals by monadnocks; the lowest one (300 meters) might easily be confused with the adjacent marine terrace, which exceeds 200 meters in elevation. An extensive and swampy lowland occurs near the mouth of the river Teshio.

E. The Yubari mountain land is separated from the Teshio section, just northward, by the antecedent gorge of the Sorachi River. In its broader outline it appears as a single tilted block. The main ridge occurs along the eastern edge; the descent east-

[8] An unpublished paper read by Y. Sassa before the Association of Japanese Geographers in October, 1928.

ward to the Furano Basin is by a bold step-fault scarp.[9] The western margin is marked by a low fault scarp which drops down to the Ishikari-Yufutsu lowland.

A study of altitude distribution, however, suggests that there are two major tilted blocks. The fronts face eastward and the back slopes give way gradually to the west. The eastern block is the higher and elevations of over 1,000 meters persist throughout the entire length of the main ridge. This block is characterized by strong relief and displays sharp ridges and steep slopes. Remnants of erosion levels are very limited both in area and number. High peaks such as Ashibetsu (1,727 meters) and Yubari (1,668 meters) may be monadnocks of a former cycle.

The western block is separated from the eastern by the longitudinal lowland formed by the valleys of the Ashibetsu and Shaparo rivers. The main ridge of this block is also found on the eastern edge, from which the descent to the east is considerably steeper than to the west. The highest peak of the main ridge is Bibae-san (987 meters). The western edge is marked by a low fault scarp which borders the Ishikari-Yufutsu lowland. Near the southern end of this section the fault scarps disappear, and the two blocks blend into a single mountain land of mild relief. A small but individual tilted block lies in the southwest corner.

F. The Mashike mountain land lies just south of the Teshio section. Its most elevated portion (1,376 meters) is a lava plateau the initial surface of which is still partly preserved. A high sea cliff towers above the Sea of Japan, but marine terraces occur only on the northern and southern extremities. The eastern margin of the area is marked by a distinct fault scarp and, with the Yubari mountain land to the east, embraces the meridional graben which forms the northern extension of Ishikari-Yufutsu lowland.

G. The Central lowland occupies the bottom of an elongated depression and lies between the meridional scarps of the Teshio and Kitami mountain lands. It is composed of four waste-filled fault basins which are separated from one another by low and inconspicuous passes. Occasional patches of diluvial terrace are

[9] Tada, F., and Tsuya, T., "The Eruption of the Volcano Tokachi," *Bull. Earthquake Res. Inst.*, 2 (1926) : 118–160.

found along the margins. From north to south these basins are known as the Tombetsu, the Nayoro, the Kamikawa, and the Furano. The floors of the three southern basins exceed 100 meters in elevation. They are drained by the middle courses of the Teshio, Ishikari, and Sorachi rivers, respectively. These rivers cut through the Teshio mountains by antecedent gorges and empty into the Sea of Japan. The northernmost or Tombetsu Basin, which lies but slightly above sea level, is bordered in part by a continuation of the marine terraces of the north shore. These terraces have been dissected by the Tombetsu River, which drains this basin. High-level gravels occur in the two middle basins — Nayoro and Kamikawa — which probably can be correlated with the marine terraces of the north coast of Hokkaido and their extension into the Tombetsu Basin. This would constitute additional evidence that a broad and epeirogenetic type of uplift recently prevailed in Hokkaido.

H. The Ishikari-Yufutsu lowland has the form of an inverted "Y" and is bordered on the east and on the west by the Yubari and Mashike mountain lands. The long northward extension is a graben and is drained by the lower course of the Ishikari River. This river meanders widely over the waste-filled floor, and cut-off remnants are found in the many ox-bow lakes. The southern part divides the Island of Hokkaido into two parts. The west arm is a low-lying alluvial plain which has been built by the rapid aggradation of the Ishikari River. The southeast arm was built up of volcanic débris to an elevation somewhat above the present level. After erosion was well advanced, a slight submergence took place which caused many swamps and extensive marshy areas in the wide shallow valleys.

I. The eastern volcanic region of Hokkaido is composed of three separate volcanic groups which lie in an east-west line between the Shiretoko Peninsula and the center of Hokkaido. Genetically, this chain of volcanoes continues through the Chishima Islands. From east to west these volcanic groups are known as (1) Kutsharo, (2) Shikaribetsu, and (3) Tokachi.

(1) The Kutsharo group has a major east-west extent of 150 kilometers from the tip of the Shiretoko Peninsula to the

volcano of Akan. Iwo-dake, in the northeast corner of the group, has erupted on several occasions within historic times. The Kutsharo Caldera, which occupies a central position in the group, has an east–west diameter of 25 kilometers and extends 20 kilometers from north to south. It is regarded as the largest caldera in Japan,[10] exceeding even the famous Aso in central Kyushu.

Many lava domes of recent origin are found in the eastern part of the caldera. A crescentic caldera lake occupies its western part. The twin volcanoes of Oakan and Meakan are outstanding in this group because of their perfect forms.

(2) The northern portion of the Shikaribetsu group is composed of three gigantic but strongly dissected shield volcanoes. The southern portion, in contrast, is made up of many small lava domes, which encircle the large and picturesque Shikaribetsu Lake.

(3) The Tokachi volcanic group, extending in a NE.–SW. direction, forms an arc that is convex to the southeast. This group may well be called the roof of Hokkaido, for not only is it located at the center of the island, but its peaks exceed all others in height. Asahi-dake (2,290 meters), in the northern part of the group, constitutes the highest point in Hokkaido. Several other peaks exceed 2,000 meters. The volcanoes of this group rest upon an erosion surface of liparitic rock, and practically all of them present a very fresh appearance. Asahi-dake is now in a stage of solfataric activity. Tokachi, which had been regarded as extinct, erupted violently on May 24, 1926, and the flow of mud which followed wrought great damage to the fields and habitations on its northwest flank.

Irumkeppu, which lies in the lowland between the Yubari and Teshio mountain lands, is isolated from the main volcanic group. It is a great, dissected shield volcano. Rishiri Island, just off the coast of the Teshio mountain land, is a markedly cone-shaped volcano.

J. The Nemuro upland is a marine terrace of unusual extent fringing the southern flank of the Kutsharo volcanic group.

[10] Tanakadate, H., *Report of the Investigation of the Volcanic Lakes in Hokkaido* (Sapporo, 1925).

Here the abrasion surface that truncates Tertiary rocks can be traced as far inland as 50 kilometers. It attains a maximum elevation of about 200 meters and is now in an incipient stage of dissection. A wide initial surface is found between erosion valleys of later origin. The valley bottoms, however, have extensive floors, many of which are excessively marshy.

K. The Tokachi coastal plain (Pl. XII, Fig. 2) is bounded on the west by the bold escarpment that determines the eastern boundary of the Hidaka mountain land and on the north by the Shikaribetsu volcanic group. The coastal plain of Tokachi stretches southeastward for 100 kilometers. Three morphological divisions may be recognized. The coastal plain proper occupies the eastern portion. It is composed of unconsolidated sand and gravel, and much of the original surface has been obliterated by erosion. The maximum elevation attained is 320 meters. The western part is a huge composite of alluvial fans, which have been built by the torrential streams descending from the adjacent mountain land. The wide flood plains of the Tokachi River and its major tributaries are entrenched well below both the fan surface and the coastal plain.

L. The Shira-nuka Hills comprise a Tertiary land of low relief, underlain by a core of Paleozoic rock. They lie between the Nemuro upland and the Tokachi coastal plain. At Ukotakisupuri the maximum elevation of 745 meters is attained. Marine terraces skirt the seaward edge.

II. NORTHEASTERN JAPAN

The northeastern division forms a contiguous land area, except for the interruption of the Tsugaru Strait; it lies between the divisions of Hokkaido Proper and southwestern Japan. The western margin of the Ishikari-Yufutsu lowland, as has been mentioned previously, is the line of demarcation in the north. The boundary in the southwest is marked by the bold fault scarps which border the western side of the Fossa Magna.

In general, the morphological features of this division are dominated by three subparallel mountain systems and their intervening lowlands, which conform to the local direction of the axis of

the Japanese arc. Each of these mountain systems is believed to be an elongated, upwarped dome. Its margins, in many places, have been dropped by faulting.[11] The trends of the fault scarps are more or less meridional in accordance with this general inclination of the mountain systems. Along the southwestern margin, however, several fault lines are distinctly transverse to the direction of the Japanese arc. Morphological fault lines are exceedingly rare in the interior of the mountain areas, except in the Abukuma mountain land. The eastern mountain lands do not form a continuous range, but, rather, are divided into three parts by two wide lowlands. The three parts are from north to south the Kitakami, Abukuma, and Kwanto mountain lands. The first two subdivisions are characterized by extensive peneplain remnants and occasional monadnocks, but the Kwanto mountain land does not contain these features, since it is in a mature stage of dissection. The two intervening lowlands are the Kitakami-Abukuma and the Kwanto coastal plain. These lowlands also separate the eastern from the central mountain lands. The latter extend the full length of the division and form a virtually unbroken range. A nearly equidistant arrangement of volcanic mountain groups is found. These cap and greatly alter the original form and altitude of the central system. Unlike the eastern mountain system, which is composed of ancient rocks — Paleozoic, gneiss, and granite — the central system is largely of Tertiary sediments overlying a core of gneiss and granite. The lowland which separates the central and western mountain systems is made up of a series of fault basins and so is somewhat unlike the lowland between the central and eastern mountain system, which was largely wrought by flexure. Elevations vary greatly in the western mountain system. In some places there is only a low hill country, though in others elevations exceed 2,000 meters. A line of fault depressions skirts the Sea of Japan, but in places these are partly buried beneath gigantic volcanoes of youthful appearance.

[11] Tsujimura, T., "The Nature of the Fault Valleys and the Geomorphologic Fault Structure of a Portion of the Japanese Islands," *Geog. Rev. of Japan*, 2 (1926) : 131–152, 192–218.

The general altitude of the central mountain system increases rapidly to the southwest and then drops sharply to the lowland of the Fossa Magna. This lowland has been greatly altered by the development of volcanoes in it.

A. The Kitakami mountain land is nearly sphenoidal. It is composed almost entirely of Paleozoic rocks, but in places the underlying granitic core is exposed and Mesozoic rocks are found near the southern margin. Considered as a whole, the Kitakami mountain land is a dissected peneplain, and extensive and well-preserved remnants of the former cycle are found. The maximum elevation of this old level, which is about 1,000 meters, occurs near the center, from which there is a gradual descent in all directions. A number of monadnocks protrude several hundred meters above the peneplain level.[12] Hayachine has an altitude of 1,914 meters. There is less evidence of marginal faulting here than in the Abukuma and Kwanto mountain masses. The westward margin, facing the longitudinal lowland of the Kitakami River, appears to be a highly dissected flexure scarp, whereas there is a gradual eastward slope to the Pacific Ocean.

The northern half of the coast line is fringed by marine terraces which attain a maximum elevation, near the northern end, of 300 meters. From here the elevation gradually decreases southward.[13] There are no indications of uplift along the southern half of the coast line, but rather the maturely dissected margin of the Kitakami peneplain has been drowned and forms a shore line of rias type.

B. The Abukuma mountain land, like the subdivision just described, is an elevated peneplain, but differs from it geologically and in the detail of landforms. Schistose granite and crystalline schists constitute the core, and the margins carry coal-bearing Tertiary sediments. In the extreme southern portion, where most of the original surface has been obliterated, Paleozoic rocks and granite predominate.

[12] Yamane, S., "An Explanation of the Geological Map, Miyako Sheet, on a Scale of 1 : 200.000," *Imper. Geol. Surv. of Japan* (Tokyo, 1909).

[13] Imamura, G., "Warping and Tilting as Seen from the Type of Deformation of Abrasion Surfaces," *Geog. Rev. of Japan*, 4 (1928) : 237–247.

The most distinguishing feature of this area is the occurrence of numerous fault valleys in the mountain interior.[14] These are subparallel and run in a NNW.–SSE. direction. In the northern half of the Abukuma mountain land extensive peneplain remnants are found. These lie at an elevation of about 1,000 meters. The southern half is offset westward, and most of its original surface has been removed. Here, too, the peneplain level is about 1,000 meters above sea level. Planation is believed to have taken place in early Tertiary or Cretaceous time.[15]

The northwest boundary is marked by fault scarps which descend to the Abukuma Valley. There is no distinct morphological fault expression on the southwestern margin; at the southern end there is a gradual merging into the Kwanto Plain. Near the eastern margin there is a distinct meridional scarp, 100 kilometers in length, which separates the older rocks from the Tertiary sediments.

C. The Kwanto mountain land is in a stage of mature dissection; no peneplain remnants have been definitely recognized, although flat-topped crests have been reported in the southeastern part.[16] This mountain land is composed chiefly of Paleozoic and crystalline rocks, except the southernmost or Tanzawa-Misaka mountains, which are of Tertiary sediments. A row of volcanoes marks the northern boundary. The eastern edge, which borders the western extension of the Kwanto Plain, is believed to be an inconspicuous and greatly modified scarp.

Three distinct sections of the Kwanto mountain land should be recognized. These are from north to south the Ashio, Chichibu, and Tanzawa-Misaka mountains. The first, which is detached from the main mass by the Tonegawa graben, is separated from the Abukuma mountain land by the Kinugawa graben. The western boundary is the valley of the Watarase River. The highest elevation in the Ashio mountains is in the

[14] Watanabe, M., "A Morphological Outline of the Abukuma Mountain Land," *Chikyu — The Globe*, 8 (1927) : 344–354.

[15] Watanabe, K., "The Morphological Development of the Joban Coastal Belt," *Journ. Geog. of Japan*, 42 (1930) : 200–210, 284–290.

[16] Homma, F., "The Geological Structure of the Tanzawa Mountain Mass," *Chikyu — The Globe*, 1 (1924) : 323–351.

northwestern corner, where the peak of Yuhi-dake reaches 1,526 meters.

The Chichibu mountains form the highest non-volcanic land in the northeastern division. In its western portion Kokushi-dake and Kimpo-san reach 2,591 and 2,595 meters, respectively. The western margin of this mountain area drops down abruptly to the lowland of the Fossa Magna.

The Tanzawa-Misaka mountains are rather high for Tertiary mountains, but do not compare in elevation with the other two associated districts. Mount Tanzawa (1,567 meters), Kuro-dake (1,792 meters), Amaga-take (1,772 meters), and a peak (1,945 meters) of unknown name in the southwest corner afford the highest elevations. The western half of this mountain mass is crescent-shaped and embraces a semicircular depression, which is now buried by Mt. Fuji. A number of narrow grabens have been reported in the eastern half.[17] The eastern and southern margins are marked by abrupt fault scarps which descend sharply to the adjacent lowlands.[18]

D. The Boso and Miura peninsulas constitute a hilly land of consolidated Tertiary tuffs with small areas of shales and sandstone. Kiyozumi-yama (383 meters), in the Boso Peninsula, is the highest elevation. Block faulting, resulting in horsts, tilted blocks, and grabens, characterize this subdivision.[19] These features have been greatly modified by erosion, but block movement is still going on, and several new seismic faults were formed by the great earthquake of 1923.[20] The fault scarps and grabens in the Boso Peninsula run in nearly straight lines, whereas those of the Miura Peninsula are curved and occur in a more or less concentric arrangement.

The southern tip of the Boso Peninsula has a narrow cut

[17] Hanai, S., "Physiographical Studies of the Terraces along the River Katsura," *Geog. Rev. of Japan*, 3 (1927) : 167–187, 308, 326, 420–430.

[18] Homma, pp. 324–327, as cited in note 16.

[19] Yamasaki, N., "Tilted Blocks of the Southeastern Part of the Boso Peninsula," *Geog. Rev. of Japan*, 1 (1925) : 1–14.

[20] Yamasaki, N., "Physiographical Studies of the Great Earthquake of the Kwanto District," *Journ. Faculty Sci., Imper. Univ. Tokyo*, Ser. 2, 2 (1926) : 77–119.

terrace with a deeply notched sea cliff at its rear. The foot of the rear cliff is 20 meters from where the terrace descends to the sea by several minor steps.[21] A new step was added at the time of the great earthquake of 1927 by an uplift of nearly 2 meters.[22] An extensive cut terrace also occurs along the southern shore of the Miura Peninsula. A minor depression followed slight dissection, and now the shore line is characterized by an intricate pattern of small bays and inlets.[23]

E. The Kwanto coastal plain lies between the Abukuma and Kwanto mountain lands. Three kinds of features characterize this extensive area: (1) the old coastal plain, which forms an extensive upland interrupted by wide valleys that are well intrenched below the upland level (Map 13); (2) a few large and maturely dissected deltas which are associated with this older and higher surface;[24] (3) the new coastal plain, composed chiefly of the intercalation of unconsolidated sand, clay, and gravel, which since emergence has been separated into many isolated table lands by the channels of numerous extended streams. Step terraces, caused by many successive uplifts, characterize the valley profile.[25] A slight depression has since drowned the lower river courses.[26] Pronounced aggradation followed and filled in most of these drowned valleys. A few, however, remain as long estuaries, and Kagamiga-ura, Kita-ura, Imba-numa, and Tega-numa, near the mouth of the Tone River, are of such origin.[27] The north shore

[21] Watanabe, A., "Preliminary Notes on the Coastal Terraces of the Southern Part of the Boso Peninsula," *Geog. Rev. of Japan*, 5 (1929) : 119–126.

[22] Imperial Army Survey Dept., A Map Showing the Vertical Movement of Land during the Great Earthquake of Kwanto in 1923 (Tokyo, 1925).

[23] Aoki, R., "Shore Line Topography of the Miura Peninsula," *Chikyu — The Globe*, 3 (1925).

[24] Asai, C., "The Geomorphology of Tama Hill," *Geog. Rev. of Japan*, 1 (1925) : 20–40.

[25] Toki, R., "Micromorphological Studies on the Kwanto Plain," *Geog. Rev. of Japan*, 6 (1930) : 1385–1422, 1501–1535.

[26] Toki, R., "The Ancient Coast Line of the Kwanto Lowland as Determined by the Present Topography and the Distribution of Shell-Mounds," *Geog. Rev. of Japan*, 2 (1926) : 597–607, 659–678, 746–773.

[27] Makiyama, J., "An Explanation of the Topographic Sheets Near Sakura," *Chikyu — The Globe*, 2 (1924) : 695.

LEGEND
ELEVATED PLAIN
OTHER UPLAND
PRESENT PLAIN
LAKE
THE KWANTO PLAIN
0 5 10 KMS

Map 13

of Sagami Bay is believed to be a fault coast, modified by marine erosion. A marine terrace, 20 meters in height, is attached to the front of the scarp.[28]

F. The Kitakami-Abukuma lowland is a longitudinal depression between the eastern and central mountain masses of northeastern Japan. The northern portion, or the Kitakami lowland proper, is not a depression of fault origin. In fact, the eastern margin appears to be a much-modified flexure scarp.[29] Throughout the entire length an erosion surface that truncates Tertiary rocks can be identified. This surface ranges in elevation from 100 to 300 meters and is believed to be of more recent origin than the Kitakami peneplain to the east.[30] The southern extremity of this lowland is highly dissected and appears as a distinct hill land. In the northern half, however, wide remnants of the initial surface remain. Along the southeast margin of the Kitakami lowland faulting and depression have taken place, causing the rugged coast about Matsushima. The western margin is covered by extensive, composite alluvial fans formed by the torrential streams descending from the central mountain mass.

The northern half of the Abukuma lowland is often called the Fukushima graben. It is a typical rift depression, the eastern and western boundaries of which are marked by abrupt fault scarps. The scarp on the western periphery cuts the flanks of the volcanoes Adakra and Azuma. The southern portion of the basin is a flexure depression; its surface is composed of flat-topped hills which maintain a uniform level of from 200 to 300 meters. This summit level is due to subaërial denudation [31] and is of more recent origin than the adjacent Abukuma peneplain.

G. The western volcanic region of Hokkaido is characterized by a variety of surface forms. An extensive volcanic plateau occupies the northwestern portion. The depressed area of the south-

[28] Otsuka, Y., "The Recent Geological History of the Oiso Block and Its Adjacent Area," *Geog. Rev. of Japan*, 6 (1930) : 129.

[29] Yamasaki, N., "A Geographical Sketch of Japan," *Scientific Japan — Past and Present* (Kyoto, 1926) : 1–32.

[30] Watanabe, M., "A Morphological Outline of the Kitakami Longitudinal Lowland," *Chikyu — The Globe*, 5 (1926) : 515–518.

[31] Watanabe, p. 350, as cited in note 14.

west is buried beneath numerous gigantic cones.[32] The Caldera lakes of Chikotsu and Toya and the circular depression of Volcano Bay are negative expressions of vulcanism. Yotei-san (1893 meters), which lies in the center of the region, is noted for its nearly perfect conical form. This mountain has undergone intense activity in recent years. Eruptions of Tarumae, Usu, and Komaga-take have been recorded during the past two centuries. Komaga-take was observed by the writers during its most recent eruption in June, 1929. At that time a great stream of hot pumice rolled down the flank, burying everything in its path.

H. The central range forms the backbone of northeastern Japan. Tertiary sediments predominate, with here and there extensive exposures of the underlying granitic and gneissic core. These exposures frequently attain much higher elevations than the surrounding Tertiary rocks. The strike of the Tertiary rock coincides closely with the major trend of the range, and the dip is in either direction from the axis. It is generally believed, but not definitely proved, that the exposed granitic and gneissic cores were islands in a Tertiary sea. It is possible that they, too, were covered by the sea and that erosion, since the uplifting of the central range, has removed their sedimentary cover. Faulting is not a feature of the interior of this subdivision, but the eastern and western margins are marked in many places by distinct fault scarps.[33] In brief, then, the central range is an elongated, warped dome whose margins have been dropped by faulting. The highest elevation of non-volcanic origin is Waga-dake (1,440 meters).

The morphological expression of this mountain land is greatly modified by the many volcanoes which cap it. These occur in clusters which lie nearly equidistant from one another. From north to south each of these groups bears the name of its major peak: (1) Osore-yama, (2) Hakkoda-san, (3) Ganshu-san, (4) Sugawa-

[32] Watanabe, A., and Imaizumi, M., "On the Distribution of Volcanoes in Japan," *Geog. Rev. of Japan*, 3 (1927) : 782; *idem*, "On the Distribution of Volcanoes in Japan," *Pap. Mich. Acad. Sci., Arts and Letters*, 14 (1930) : 433–436. The latter article contains a valuable map showing the distribution of volcanoes of Japan.

[33] Tsujimura, as cited in note 11.

dake, (5) Funagata-yama, (6) Zao-san, and (7) Bandai-san. In each group there are one or more overtowering conical volcanoes accompanied by numerous minor attendants. Osore-yama, Zao-san, and Bandai-san have recent records of eruption. The eruption of Mt. Bandai in 1888 is the most famous. At that time its northern portion was blown away and the resulting débris accumulated on its northern flank, forming numerous small lakes, which are still conspicuous features of the landscape.

I. The volcanic region of central Honshu is a crescent-shaped area which is convex eastward. It is a region of many volcanoes of varied forms, which are of both recent and ancient origin. The younger volcanoes lie along the outer margin and the older and more dissected ones are within.[34] Nasu (1,917 meters) and Asama (2,542 meters), which are constantly smoking, are well known to the Japanese people.

J. The central basins comprise a series of depressions that extend nearly the entire length of northeastern Japan. From north to south these depressions are known as: (1) Suttsu Bay, (2) Volcano Bay, (3) Mutsu Bay, (4) Hanawa Basin, (5) Odate Basin, (6) Yokote Basin, (7) Shinjo Basin, (8) Yamagata Basin, (9) Yonezawa Basin, (10) Inawashiro Basin, and (11) Aizu Basin. The three northernmost have been invaded by the sea, whereas the Inawashiro Basin is occupied by a lake and the remaining seven are waste-filled. The basins are grabens, more or less oblong, and their eastern and western margins are marked by fault scarps in varying stages of dissection. The rivers which drain the different basins cut through the mountain lands to the west in antecedent gorges and empty into the Sea of Japan. The rivers Omono, Noshiro, Mogani, and Aga are of this type.

In the Yokote Basin a small tilted block is found at the foot of the fault scarp which separates the basin from the central mountains. During the destructive earthquake of 1896 this block showed renewed activity,[35] and a new seismic fault with a maximum vertical displacement of 3 meters appeared just at the

[34] Watanabe, p. 786, as cited in the first article in note 32.

[35] Yamasaki, N., "Das grosse japanische Erdbeden im nördlichen Honshu am 31. August, 1896," *Pet. Mitt.*, 46 (1900) : 249–255.

foot of the block front.[36] This fault does not present a continuous morphological expression, but can be seen at intervals along the entire 60 kilometers of the eastern margin of the basin.

K. The Oshima mountain land is a warped structure in a stage of mature dissection. It is characterized by moderate relief and is girdled by narrow marine terraces. In the northern and southern peripheries occasional peaks exceed 1,000 meters in elevation. Kariba-yama (1,520 meters) is a huge, maturely dissected lava dome at the sea's edge in the northwest portion of the region.

The marine terraces are well developed, but in width they do not compare with the terraces of the Hokkaido Proper division. The highest terrace (300 meters) lies behind Esashi on the Sea of Japan, where the former sea cliff can be identified.

L. The Tsugaru horst runs in a NNW.–SSE. direction, with its eastern and western margins marked by distinct fault scarps. The eastern slope descends to the Bay of Aomori by two abrupt steps. The highest elevation in the region is attained by Okura-dake (677 meters).

M. The Dewa Hills extend for a distance of 160 kilometers from north to south, interrupted only by the gorges of the rivers Noshiro and Omono. The portion of this subdivision lying north of the Omono River is a maturely dissected, low mountain land. It is characterized by moderate relief and its most prominent peaks reach to about 1,000 meters. The portion south of the Omono is a hill country in a youthful stage of dissection. Extensive flat-topped surfaces are found,[37] and the general elevation is but slightly in excess of 400 meters.

The southern border of the Dewa Hills is marked by the antecedent gorge of the Mogami River. The northern border, near Ajigasawa, is the Sea of Japan, where three distinct levels of marine terrace are found. The maximum elevation on the uppermost terrace is 120 meters.

N. The Asahi-Iitoyo mountain land is a maturely dissected

[36] Fukui, E., "Geomorphological and Climatological Studies of the Yokote Basin," *Geog. Rev. of Japan*, 4 (1928) : 23–25.

[37] Ohashi, R., "The Physiographic History of the Dewa Range; A Contribution to the Block-Upheaval Theory of Mountain Building," *Geog. Rev. of Japan*, 3 (1927) : 14.

area of high relief. Extensive exposures of the granitic core occur in the highest central part. The eastern margin is downfaulted into the Yamagata, Yonezawa, and Aizu basins, whereas the western boundary is marked by the faulted coast along the Sea of Japan and the long continuous fault scarp which towers above the Echigo Plain.

The maximum elevation of this region is attained by Tainichi-dake (2,128 meters), which lies in the south-central part. The highly dissected volcano, Gas-san (1,924 meters), is a prominent feature of the northern part. The River Aga, after draining the Aizu Basin, cuts through the southern part of the area at nearly a right angle to the trend of the mountains.

O. The block mountains of Echigo are made up of many parallel blocks of Tertiary sediments. They are elongated in a NE.–SW. direction, and each one is regarded as a distinct warped dome whose margins have been dropped by faulting. Thus the direction of the fault system accords with that of the different mountain ranges. The Shinano River flows along the foot of one of these fault scarps for almost its entire length.

P. The delta plains of the Sea of Japan include, from north to south: the plains of (1) Tsugaru, (2) Noshiro, (3) Shonai, (4) Echigo, and (5) Takata. Each occupies a fault depression and lies at the mouth of a large river flowing into the sea. Delta deposits have in each case formed extensive alluvial plains. The fault scarps which form the inland borders of these depressions intersect at low angles the axis of the island arc.[38] Farther to the south the Toyama Plain and Wakasa Bay are of this same character.

The Tsugaru and Shonai plains are now partly buried by the gigantic conical volcanoes of Iwaki (1,625 meters) and Chokai (2,230 meters), respectively.

Q. The islands of the Sea of Japan, which lie in a line parallel to the west coast of Honshu and the southwest coast of Hokkaido, are, from north to south: (1) Okushiri, (2) Oshima and Koshima, two small volcanic islands off the coast of southwestern Hokkaido, not to be discussed here; (3) Oga Peninsula, (4) Tobishima and Awashima, and (5) Sado.

[38] *Ibid.*

Okushiri rises out of the sea by a series of stepped marine terraces. In this manner there is quite a uniform ascent from all sides toward the central and highest part.[39] The highest elevation is itself a flattish surface (585 meters) and has been abraded. This is the most elevated abrasion surface so far identified in Japan.[40]

Oga Island is now a part of the Oga Peninsula, a *tomboro* which has been land-tied by the deposits of the Noshiro and Omono rivers. Between the island and the mainland the land is low and embraces the shallow Lake Hachiro-gata. Several levels of marine terrace, the highest of which lies at about 200 meters, border the island. The small but picturesque volcano, Kampu-san (356 meters), is on the western edge of Lake Hachiro-gata. Many lakes and bays are in the northwest part.[41]

Tobishima and Awashima are small islands of low elevation. They are described as emerged abrasion platforms.[42]

Sado, the largest island in the Sea of Japan, is shaped like an anvil and is composed of two parallel warped ranges, which embrace a low waste-filled depression between them.[43] The general trend of the ranges is parallel to those of the adjacent mainland. The margins of each range are believed to have been dropped by faulting, but the scarps are submerged below sea level.[44] Flat-topped surfaces occur at several levels and characterize even the crests of the mountain ranges. The highest elevation on the island is in the northern range, where Kimpo-san reaches 1,173 meters. Marine terraces border the coast lines of the mountain ranges; the highest one lies at 120 meters.[45]

[39] Watanabe, A., "Marine Terraces of Okushiro Island, Hokkaido," *Geog. Rev. of Japan*, 4 (1928) : 298–300.

[40] Tsujimura, T., "The Distribution of Coast Topography in Japan," *Toyogakugei-zasshi*, 44 (1928) : 304.

[41] Watanuki, I., "Tomboro and Maars of the Oga Peninsula," *Geog. Rev. of Japan*, 1 (1925).

[42] Ohashi, R., "An Outline of the Tobishima Land Block," *Chikyu — The Globe*, 7 (1931) : 284.

[43] Hall, R. B., "Sado Island," *Pap. Mich. Acad. Sci., Arts and Letters*, 16 (1931) : 278–281.

[44] *Ibid.*, p. 278.

[45] Shimomura, H., "Geomorphological Glimpses of Sado Island," *Geog. Rev. of Japan*, 1 (1926).

R. The Transversal lowland, or Fossa Magna,[46] forms the southwestern limit of the northeastern division. An almost continuous fault scarp, whose general height is over 2,000 meters, extends across middle Honshu from the Sea of Japan to the Pacific and forms the northern boundary of the Transversal lowland.[47] A string of fault depressions lies along the foot of this great fault scarp. These are, from north to south: the Himekawa depression, the Matsumoto graben, the Suwa graben, and the Kofu Basin. The elevations of the basin floors are Matsumoto (450 meters), Suwa (700 meters), and Kofu (250 meters). Clusters of gigantic volcanoes have buried parts of the original lowland. These volcanic areas have separated the lowlands just mentioned from the basins of Saku-daira and Zenkoji-daira, which lie at the foot of the adjacent mountains of the Inner Zone of southwestern Japan. The volcanic clusters are three in number and from north to south are called the Myoko group, the Yatsuga-take group, and the Fuji-Amagi group. The first is composed of three conical volcanoes, of which Mt. Myoko (2,446 meters) is the most prominent. The second is made up of Kirigamine, Tateshina (2,530 meters), Yatsuga-take (2,899 meters), and Kayaga-take (1,704 meters). All the volcanoes of this group are somewhat modified by erosion. The third or Fuji-Amagi group contains diverse volcanic forms. Mt. Fuji (3,778 meters) rises out of the semicircular depression that is partly inclosed by the Misaka mountains and is justly famous for its nearly perfect conical form.

The maturely dissected volcano, Ashitaka, lies to the south of Mt. Fuji. Hakone has a huge caldera on top, the western part of which is occupied by Lake Ashinoko. The eastern part of this caldera contains many lava domes of recent origin. All the volcanoes in the Izu Peninsula, excepting the smaller parasitic cones, are strongly dissected. The eastern half of Atami and the western half of Daruma are believed to have been depressed by faulting in the adjacent bays of Sagami and Suruga.

[46] Naumann, E., "Neue Beiträge zur Geologie und Geographie Japans," *Pet. Mitt.*, 23 (No. 108) : 17–36. Naumann first used the term "Fossa Magna"; it has since been generally adopted.

[47] Tsujimura, T., "The Formation of a Composite Fault Scarp," *Journ. Geol. Soc. of Tokyo*, 40 (1926) : 75–90.

The great line of volcanoes which rises above the floor of the Fossa Magna extends out into the Pacific as volcanic islands. Several of these island volcanoes have records of recent eruption. Oshima mildly, but constantly, emits smoke. Izu Shichito is made up of many minor volcanic islands arranged in a NE.–SW. line. Miyakejima, Mikurajima, Hachijoshima, and Aogashima extend farther south into the Pacific. The Ogasawara Islands are composed chiefly of older Tertiary rocks, but Iwo-jima, still farther south, is of volcanic origin. New islands have twice appeared, in 1904 and 1914, near Iwojima, but have been cut away in a few months by wave action.

Southwestern Japan

Southwestern Japan has been divided into two distinct geotectonic provinces since the earliest geological investigations. The median line extends from the Suwa graben southward along the valley of the River Toyo. Its direction is then westward across the Kii Peninsula, where it follows the valleys of the Kushida and Kinokawa, and across Shikoku, along the Yoshino Valley and the northern flank of the Ishizuchi Mountains. The line then continues across Kyushu to the town of Imari.[48] The land lying north and west of this line is known as the Inner Zone and is composed mainly of granite, Paleozoic and volcanic rocks, which have been greatly disturbed. The Outer Zone, in contrast, is characterized by a regular, zonal arrangement of crystalline schist, Paleozoic and Mesozoic rocks.[49] Early in the geological work in this area it was noted that the rocks of the Inner Zone are overthrust upon those of the Outer Zone.[50]

The morphologic features of these two zones are equally in contrast, although a direct relationship between geologic structure

[48] Yabe, H., "The *Nagasaki Dreieck* of Richthofen in Northern Kyushu," *Journ. Geol. Soc. of Tokyo*, 32 (1925) : 201–208.

[49] Ogawa, T., "On the Geotectonics of the Japanese Islands," *Journ. Geog. of Japan*, 11 (1899) : 413–423, 478–505, 537–560, 685–694, 810–820; 14 (1902) : 108.

[50] Ogawa, T., "The Geotectonics of the Japanese Islands," *Compte rendu de la X^e^ session du Congrès Géologique International* (1907), pp. 1273–1274.

and surface feature is not always clear. The morphological boundary line between the two divisions, however, coincides closely with the geotectonic line, except in the western portion of Kyushu, where it deviates in a southwestern direction and reaches the coast at Yatsushiro rather than at Imari.[51] A high and continuous fault scarp that cuts the northern edge of the Outer Zone marks this morphologic boundary.[52]

The outstanding surface character of the Inner Zone results from complex block-faulting unaccompanied by strong warping. The Outer Zone, on the other hand, owes its surface character to broad upwarping [53] with scarcely any visible results of faulting. Thus, the mountain land of the Inner Zone is broken by many fault depressions and is not continuous, in sharp contrast with that of the Outer Zone.[54] The general elevations of the two zones are also strikingly different. A few peaks exceed 1,200 meters in the Inner Zone, but in the Outer Zone altitudes of 2,000 meters are maintained over wide areas.

III. THE INNER ZONE OF SOUTHWESTERN JAPAN

The greatest density of fault lines and the most complicated fault net in all Japan is found in the Inner Zone and has resulted in a most intricate pattern of horsts and grabens. These forms stand out in sharp contrast with those of the northeastern division, where a sparse and regular meridional arrangement of fault lines is the rule. After the peneplanation of this region, which is believed to have taken place in Pliocene time,[55] block-faulting took place. Every variety of block mountain can be found in this area, but the true horst type predominates. Peneplain remnants are still preserved on the tops of many of them. In the Kinki district (Map 14) depressed blocks are conspicuous, and most of them are

[51] Shimomura, as cited in note 45.

[52] Tsujimura, T., "The Geomorphological Significance of the Median Line of Southwestern Japan," *Journ. Geol. Soc. of Tokyo*, 31 (1924) : 110–119, 155–166, 210–219.

[53] Otsuka, Y., "The Inclosed Meander of the River Shimanto, Shikoku Island," *Geog. Rev. of Japan*, 3 (1927) : 397–419.

[54] Tsujimura, pp. 11–17, as cited in note 5.

[55] Yabe, H., "A Brief Summary of the Tertiary and Post-Tertiary Geologic History of Northern Kyushu," *Geog. Rev. of Japan*, 2 (1926) : 1–16.

waste-filled. In the Chugoku mountain land, to the west, fault valleys are of common occurrence and cut the mountain mass into a complex mosaic. The proportion of the area which is depressed is greater in the southwest. In the Kinki district the land is divided almost equally between basins and uplifted blocks. Here, too, Setouchi or "Inland Sea," occupies a vast depression of fault origin. The western extension of this same depression into northern Kyushu is now buried by many volcanoes. The southwestern portion of the Inner Zone is largely a granitic land and, as Professor Tsujimura has pointed out, fault topography predominates in such lands and is generally lacking in the regions of Paleozoic sediments in Japan.[56]

In general, elevations in the Inner Zone decrease to the west. The mountain lands of Hida and Kiso, which constitute the highest part of Japan and top the great fault scarp that marks the western boundary of the Fossa Magna, attain altitudes of over 3,000 meters. Near by, the Central Plateau averages about 1,700 meters, whereas in the Kinki district half the land is occupied by waste-filled basins lying but slightly above sea level, and the uplifted blocks are not of great height. The Tamba Plateau, however, again increases in elevation and attains altitudes in excess of 1,200 meters. In the Chugoku mountains the highest peaks scarcely exceed 1,300 meters; in Kyushu, Seburu-yama (1,055 meters) is the only peak reaching 1,000 meters.

The northern periphery of the Inner Zone is sparsely dotted with volcanoes, which have, in most places, formed in circular depressions. The Hida mountain land is capped by a single row of volcanoes. The landscape of the westward extension of the Setouchi depression in Kyushu is also dominated by volcanoes.

The coastal topography of the Inner Zone is, except for the few limited localities where marine terraces occur, of the submerged type of shore line.

A. The Hida mountain land is an area of high relief, in a stage of mature dissection. No peneplain remnants are found. The eastern margin is marked by a bold fault scarp, which descends abruptly into the Matsumoto graben. The southwestern border

[56] Tsujimura, pp. 11–12, as cited in note 5.

is the less prominent Adera scarp. The highest peaks are found near the center, where Yariga-take and Hodaka-dake reach altitudes of 3,180 meters and 3,103 meters, respectively. Cirques, in the higher levels of several of the major peaks, bear evidence of former glaciation (Pl. XIII, Fig. 1).[57] A row of volcanoes extends from north to south and tops the Hida mountain land. Best known among them are Imo-dake (2,458 meters), which is constantly emitting smoke, and Norikura-dake (3,026 meters) and On-take (3,063 meters), which are of nearly perfect conical form.

B. The Kiso mountain land is a typical horst, elongated in a NNE.–SSW. direction. It is composed chiefly of granite. The eastern margin drops abruptly into the Ina graben, and the western side is cut down by step faults to the Kiso Valley.[58] The highest elevation is attained by Komaga-take (2,956 meters), whence the main ridge gradually descends southward. Cirque remnants have been reported near the summit of Komaga-take.[59] In the southern part of this subdivision an elevated peneplain in an incipient stage of dissection is found at an altitude of 500 to 700 meters.[60] The Chita Peninsula, extending to the southwest, is an area of Tertiary hills.

C. The Central Plateau occupies a broad area lying between the Hida mountains and the highly block-faulted Kinki district. Flat-topped crests are reported from many widely separated localities,[61] and although none of them are particularly extensive, the general harmony of summit level strongly indicates former peneplanation. Some of the peaks, probably monadnocks, exceed 1,000 meters in elevation. Of these Betsu-yama (2,319 meters) is the highest. Several volcanoes surmount the plateau level and lie

[57] Yamasaki, N., "Did Glaciers Exist in Japan?" *Journ. Geol. Soc. of Tokyo*, 9 (1902) : 361–369, 391–398; *idem*, "Glaciation of the Mountains of Japan," *Am. Journ. Sci.*, 3 (1922) : 131–137.

[58] Tsujimura, as cited in note 11.

[59] Oseki, K., "On the Morphology of Komaga-take, Kiso Range," *Journ. Geol. Soc. of Tokyo*, 24 (1917) : 511–521.

[60] Sugiyama, M., "The Evenness of the Mikawa Peneplain," *Geog. Rev. of Japan*, 6 (1930) : 1269–1286.

[61] Okayama, T., "Remnants of the Surface of Low Relief in Central Japan and Problems Related to Them," *Geog. Rev. of Japan*, 6 (1930) : 1659–1681.

near the center of the region. Haku-san (2,702 meters) is the most conspicuous. The southern part of the Central Plateau is composed chiefly of Paleozoic sediments, whereas the northern moiety is made up of a profuse variety of volcanic rocks. Fault lines running in various directions may be recognized, but there are no wide waste-filled depressions. The margins of the subdivision, however, are marked in most places by fault scarps. The well-known Midori seismic fault, with a vertical displacement of three meters, was produced on the margin of the Neo Valley in 1891.[62] The littoral plain of Kaga extends along the Sea of Japan.

D. The Noto Peninsula is included in the Inner Zone division because of its location, but geologically and morphologically it is more like northeastern Japan.[63] In general, it may be described as a low, warped dome of Tertiary sediments, and its margins are in places downthrown by faulting. The famous Oochigata graben lies in almost the exact center of the region, and the southeastern margin of the peninsula is cut by faulting. The direction of the faults just mentioned is approximately parallel to those of Echigo and Sado Island in northeastern Japan. Similarly, the Toyama Plain in the southeast part of the region is of the same type as the plains to the north (Pl. XIII, Fig. 2). Like them, it is a fault depression [64] partly filled with alluvium and elevated deltas, with a maximum elevation of 400 meters.[65]

E. The block mountains and fault depressions of the Kinki district occupy about equal parts of the area and give it a distinctive surface character (Map 14). After peneplanation, faulting took place and the land was broken into many blocks. Some were uplifted and others were depressed. As the major trend of the fault net coincided with the trend of the island arc in this part of Honshu,[66] and was meridional, most of the resulting block moun-

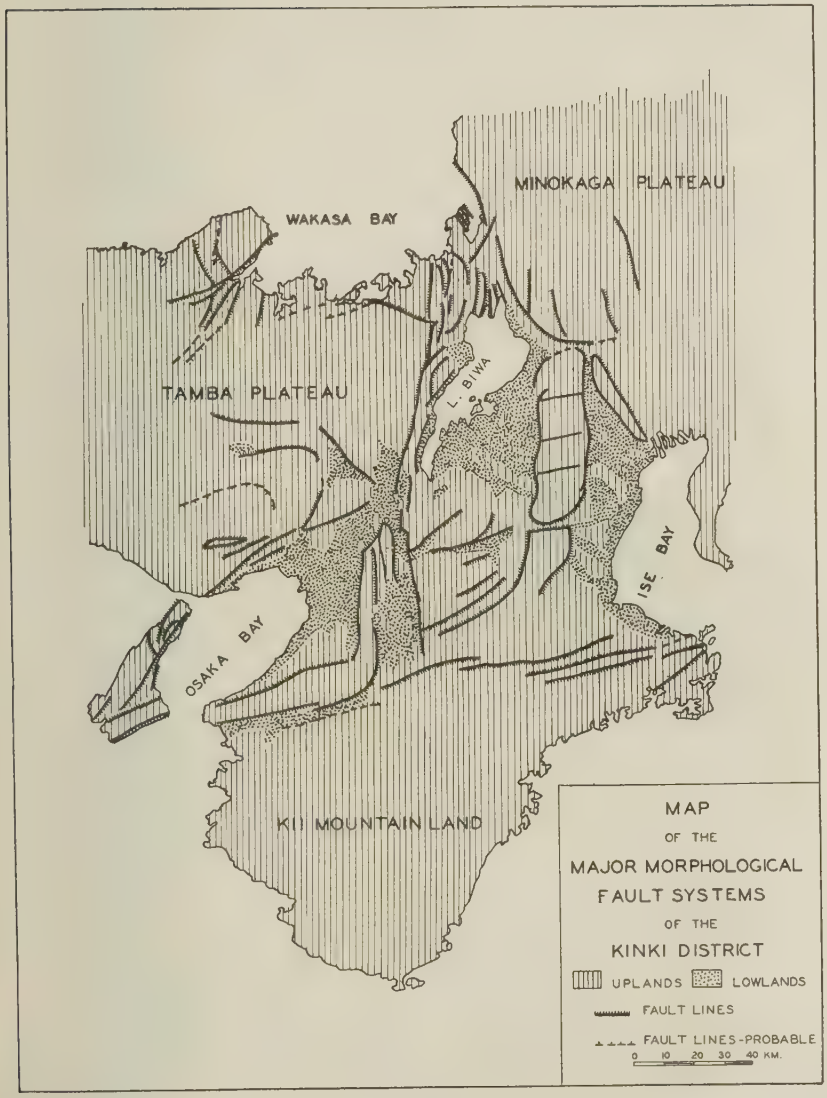
[62] Koto, B., "On the Cause of the Great Earthquake in Central Japan, 1889," *Journ. Coll. Sci. Imper. Univ. Tokyo*, 5, Part 4, pp. 255–355.

[63] Mochizuki, K., "The Paleogeography and Physiographic History of the Southern Part of the Noto Peninsula," *Geog. Rev. of Japan*, 4 (1929) : 1044–1064.

[64] Tsujimura, T., "A Type of Fault Scarp Found at the Northern End of the Hida Range," *Geog. Rev. of Japan*, 2 (1926) : 679–695.

[65] Watanabe, A., "On Some of the Elevated Deltas of Japan," *Geog. Rev. of Japan*, 4 (1928) : 5.

[66] Tsujimura, pp. 132–152, 192–218, as cited in note 11.


MINOKAGA PLATEAU
WAKASA BAY
TAMBA PLATEAU
L. BIWA
ISE BAY
OSAKA BAY
KII MOUNTAIN LAND
MAP
OF THE
MAJOR MORPHOLOGICAL
FAULT SYSTEMS
OF THE
KINKI DISTRICT
UPLANDS
LOWLANDS
FAULT LINES
FAULT LINES-PROBABLE
0 10 20 30 40 KM.

Map 14

tains and fault depressions were elongated in the same direction. Another feature of this region is the persistence to the present time of extensive and well-preserved peneplain remnants on top of the uplifted blocks.[67]

The Yoro Mountains represent a transition type between a tilted block and a true horst. The eastern front of the block rises abruptly above the Nobi Plain. Immediately westward, the Suzuka Mountains comprise a horst of the "Voll" type. All sides are bounded by distinct fault scarps and the block extends north and south for 100 kilometers. Many fault lines traverse the interior of this area as well.[68] The highest elevation in the Suzuka Mountains is found in Amagoi-dake (1,238 meters). About it are extensive level surfaces of the former cycle. The low and historically famous pass of Sekigahara separates this region from the Central Plateau.

The Kasagi Mountains, or plateau, as they are frequently called, lie farther westward. The western margin of this block is cut down by a high, steep fault scarp to the Yamashiro and Yamato basins. Particularly extensive and well preserved are the peneplain remnants on its top; residual gravels have been reported from a number of localities.[69] The interior is traversed by many faults that run in a general NE.–SW. direction.[70] The Iga Basin, which is a relatively minor fault depression, lies in the eastern part of this mountain land.

Above the western margin of the Yamato Basin rise the Ikoma and Kongo mountains. The former, the one farther north, is composed of three tilted blocks, with their fronts facing westward.[71] The front of the western block, which is the highest, faces the Settsu (Osaka) Plain by a high and steep fault scarp. The

[67] Cushing, S. W., "Coastal Plains and Block Mountains of Japan," *Ann. Assn. Am. Geog.*, 3 (1913) : 43–61.

[68] Tada, F., "On the Genesis of the Suzuka Mountain Land," *Journ. Geol. Soc. of Tokyo*, 35 (1928) : 375–381.

[69] Tsujimura, p. 48, as cited in note 5.

[70] Tada, F., "The Mode of Recent Deformation of the Shimagahara Land Block in Iga Province as Determined by Tracing the Vertical Change of River Courses," *Bull. Earthquake Res. Inst.*, 7 (1929) : 531–557.

[71] Makiyama, J., "The Building of the Ikoma Range," *Chikyu — The Globe*, 6 (1926) : 87–94.

Kongo is a horst, whose eastern and western margins are distinct fault scarps (Pl. XIV, Fig. 1). The western slope is a continuation of the bold block front of the Ikoma Mountains. The Izumi Mountains, farther south, likewise comprise a horst, but its major extent is east and west, in accord with the median line through the Kii Peninsula.

Between the Omi Basin and the Bay of Wakasa is a low mountain land which has been downfaulted between the Central Highland, on the east, and the Tamba Plateau.[72] Numerous meridional faults traversing this area cause it to present a very broken surface.

Numerous fault depressions are found in this area, but only the six largest ones will be described. Each has at least part of its floor covered by alluvium, and diluvial terraces on the margins indicate the repeated vertical movement which has taken place.[73] The Nobi (Ise) Plain lies just east of the Suzuka horst. Here, the northern end of the depressed Ise Bay has been filled in by the delta of the Kiso River. The Omi (Biwa) Basin contains in addition to an alluvial plain Japan's greatest lake, Biwa. This depression is relatively recent, as is indicated by the unburied Lake Biwa and by the many small isolated hills scattered about the basin floor. The latter suggest that a stage of mature dissection had been achieved before depression took place. The Yamashiro (Kyoto) and Yamato (Nara) basins were once continuous, but are now separated by the diluvial hills of Narasaka. The rivers Yodo and Yamato, which flow from the adjacent highlands and drain these two basins, reach the sea by the depressed Osaka Bay. Their combined deltas have filled the northeastern end of the bay and have formed the Settsu (Osaka) Plain. The Kinokawa graben is a narrow, waste-filled rift through which flows the Kino River. It lies between the Izumi horst and the Kii mountain land of the Outer Zone.[74]

F. The Tamba Plateau attains its greatest elevation (1,214

[72] Yamasaki, N., and Tada, F., "The Geomorphology and the Geotectonic Structure of the Region North of Lake Biwa," *Bull. Earthquake Res. Inst.*, 2 (1924) : 85–108.

[73] Tsujimura, T., *Geomorphology* (Tokyo, 1923), pp. 329–331.

[74] Tsujimura, T., "The Fault Scarp and the Fault Line Scarp," *Journ. Geol. Soc. of Tokyo*, 30 (1923) : 269–279.

meters) on the eastern margin, which rises in a bold fault scarp above the Omi, Yamashiro, and Osaka plains. There are flat-topped crests on these highest lands;[75] they have not been identified elsewhere. There is a gradual decrease in elevation from east to west, but the rough summit level of the plateau as a whole and the flat-topped crests just mentioned suggest a maturely dissected peneplain.[76] The Tamba region is composed chiefly of Paleozoic sediments and of patches of granite on the margins. Fault lines traverse the interior of the plateau, but the vertical displacement has not been sufficient to produce waste-filled basins of any great size. The Kameoka[77] and Shinoyama basins are representative of the type which does occur. Displacement has been more pronounced along the margins, resulting in the Hira horst in the northeast and the Rokko horst in the south.

In the north the plateau is separated from the Bay of Wakasa by a fault scarp. The eastern and western margins of the bay are faulted coast lines. Wakasa Bay, then, is a depressed block over which there has been an invasion of the sea.[78] The coasts to the east and west, which are not fault coasts, are fringed by marine terraces. The terraces to the east of the bay have a maximum elevation of 120 meters;[79] those to the west attain an elevation of 60 meters. They gradually decrease in height, receding from the fault margins of Wakasa Bay; the terrace along the north shore of the Tango Peninsula finally disappears and is replaced by a submerged shore line in the extreme west.[80] The Tango Peninsula is traversed by numerous fault lines.[81] The Mineyama graben

[75] Homma, F., and Kimizuka, V., "The Building of the Rokko Mountain Land," *Chikyu — The Globe*, 10 (1928) : 255–262; *idem*, p. 194, as cited in note 5.

[76] Ogawa, T., *Land and People of the Kinki District, Studies in Human Geography* (Tokyo, 1928), p. 208.

[77] Tsujimura, T., "Some Characteristic Topography Resulting from Faulting," *Toyo-Gakugei-Zasshi*, No. 459 (1919).

[78] Yamasaki, N., and Tada, F., "The Okutango Earthquake of 1927," *Bull. Earthquake Res. Inst.*, 4 (1928).

[79] Ichikawa, W., "The Physiography and Physiographic Development of Western Echizen," *Geog. Rev. of Japan*, 5 (1929) : 1058–1072.

[80] Tada, F., "The Coast Topography of the Okutango Peninsula," *Chiri-Kyoiku*, 7 (1928).

[81] Tada, F., "The Physiographic History of the Okutango Peninsula," *Bull. Earthquake Res. Inst.*, 5 (1928).

crosses the neck of the peninsula, where a new seismic fault was reported after the destructive earthquake of 1927, with a horizontal displacement of 2.83 meters and a vertical displacement of 0.69 meter.[82]

G. The eastern Chugoku mountain land lies to the west of the Tamba Plateau and is in a stage of mature dissection. The southern boundary is a long, continuous fault scarp, running in a NWW.–SEE. direction. By this escarpment, the general altitude of the mountain land, which is in excess of 1,000 meters, gives way suddenly to a hilly land of less than 500 meters in elevation. Depression has taken place along the northern margin, resulting in a slope of steep declivity and many small bays and inlets on the shore of the Sea of Japan.[83] Very little faulting has taken place in the interior.

The Chugoku mountain system attains its highest elevations in this subdivision. Several peaks exceed 1,300 meters, including Tosen (1,388 meters), Mimuro-yama (1,358 meters), and Okinosen (1,319 meters). Two groups of volcanoes rise well above the general mountain level. These are Hyonosen in the east and Daisen in the northwest. The former group bears the name of its major member (1,510 meters), which is strongly dissected. The latter is named after the gigantic lava dome of Daisen (1,773 meters), which has many attendant volcanoes and lies in a semicircular depression on the edge of the Sea of Japan.

H. The Kibi Plateau lies in the heart of the Chugoku mountain system and partly separates the eastern and western subdivisions of that system. It was in this area that Professor Koto, a quarter of a century ago, was first attracted by peneplain topography.[84] The Kibi Plateau is a peneplain in an early stage of dissection. Deep gorges separate extensive remnants of the original surface. Numerous small monadnocks protrude above the general level, which truncates a variety of Paleozoic and Mesozoic sediments and granite. The average elevation of the original surface is be-

[82] Yamasaki and Tada, p. 1065, as cited in note 78.

[83] Tsujimura, p. 151, as cited in note 5.

[84] Koto, B., "On Chugoku Type Topography," *Publ. Earthquake Invest. Comm.*, 64 (1909).

tween 500 and 600 meters. Near the northern margin, and especially in the vicinity of Tsuyama, this level lies at about 700 meters, from which there is a gradual slope southward. Near the city of Okayama it has descended to about 300 meters. The northern limit is the foot of a strongly eroded fault scarp which marks the eastern margin of the eastern Chugoku mountain land. From the top of this scarp and included in eastern Chugoku numerous small, flat-topped crests are found. These are believed to be remnants of a more elevated and consequently more dissected portion of the same peneplain which is found in the Tamba Plateau. The age of this peneplain surface was regarded by Professor Koto as Cretaceous, but later work by Professor Yabe has established it as Pliocene.[85]

I. The western Chugoku mountain land changes its equational trend, west of the Kibi Plateau, to one which is NE.–SW. A highly developed geomorphological fault structure characterizes this region. The density of its fault net has no equal in all Japan. The direction of the major system is in accordance with the trend of the mountain ranges. A secondary system intersects the major one at right angles. Thus the land has been cut into many narrow horsts, which extend NE. SW. The highest ridge is in the north-central part, where several peaks exceed 1,300 meters. Okametaniyama (1,346 meters) is the most elevated. Step by step, from this highest portion, each elongated horst marks the descent to both the Inland Sea and the Sea of Japan. Each fault line is marked by a fault valley, but there are no grabens. The same trend and geomorphologic structure exist along the entire stretch of the north shore of the Inland Sea. The southern extremity of the Kibi Plateau has had its initial surface entirely obliterated by erosion and has been intricately cut by faulting. South of the eastern Chugoku mountains the hill land, which has been previously mentioned, is likewise intricately faulted. Here the major system runs NW.–SE., in accordance with the great scarp which marks the southern limit of eastern Chugoku, but a secondary system, which runs equatorially, intersects it diagonally. Slight depression has taken place since the fault lines were formed and has

[85] Yabe, p. 16, as cited in note 55.

resulted in broad, waste-filled valleys along the entire northern shore of the Inland Sea.

Many small lava domes and lava plateaus are scattered along the margin of the western Chugoku mountain land which is by the Sea of Japan. Sambe-yama (1,126 meters), which is the largest and best known of the volcanoes, gives its name to the group. In the western part of the subdivision is the Akiyoshidai region, which is famous in Japan for its karst surface.[86] This karst is developed on a slightly elevated peneplain which truncates Paleozoic limestone of complex structure.[87] The western extremity, near Bakan Strait, is an area of unusually low relief. The highest elevations scarcely exceed 100 meters and subdued forms prevail.[88] This type of surface is far from characteristic of "Old Japan."

J. The block mountains and fault depressions of northern Kyushu, like those of the Kinki district, give a pronounced surface character. The distinctive features of this area are block mountains of various trends, and intervening fault depressions, most of which are waste-filled. Peneplain remnants are well preserved on a number of the crests. The age of this former cycle is believed to be Pliocene.[89]

The Chikuho Mountains occupy the eastern portion of the region and comprise a group of fault blocks which extend more or less meridionally.[90] Most of the fault scarps have been greatly modified by erosion. Near the southwestern margin a series of faults mark the descent, step by step, to the alluvial plain of Tsukushi.

The Seburu Mountains, in the western part, comprise a great horst which has been cut into many secondary blocks by faulting. The major extent of these blocks is in a NW.–SE. direction. Peneplain remnants have been reported from the higher crests.

[86] Yamasaki, N., "Karst Landscape of Akiyoshidai," *Journ. Geol. Soc. of Tokyo*, 13 (1906) : 337–344.

[87] Ozawa, G., "The Geological History, Landforms and Underground Drainage of Akiyoshidai," *Geog. Rev. of Japan*, 1 (1925) : 32–49, 144–154, 237–251.

[88] Tsujimura, pp. 261–263, as cited in note 5.

[89] Yabe, as cited in note 55.

[90] Toki, R., "The Geomorphological Development of the Southern Part of the Eastern Chikuho Blocks," *Geog. Rev. of Japan*, 4 (1928) : 1065–1076.

Seburu-yama (1,055 meters), which is the highest peak, gives its name to the entire mass. A prominent fault scarp marks the boundary between the Seburu Mountain and the Tsukushi Plain. It curves sharply and finally intersects the main fault system at an acute angle. The northern coast line is of a submerged type in an advanced stage of marine erosion. Sand bars and spits have greatly simplified the outlines of the shore.

In the southern part of the subdivision is the Miminari tilted block. Its high, frontal scarp faces northward and towers above the Tsukushi Plain. This scarp coincides with, and forms a part of, the so-called Matsuyama-Imari line, which is the geotectonic, but not the geomorphologic, median line through Kyushu. The interior, and southern, portion of the Miminari mountains is cut by several meridional fault valleys.

Between the elevated blocks of Seburu and Miminari lies the low, alluvial plain of Tsukushi, which is drained by the Chikugo River. The southern extension of this depression is occupied by the shallow Sea of Araike.

K. The Setouchi Depression is nearly inclosed between the Chugoku Mountains of Honshu and the mountains of Shikoku Island. The fact that the Inland Sea of Japan was formed by downfaulting has long been accepted. In 1894 Professor Penck published his famous monograph [91] in which the fault origin of the basin was pointed out. Numerous Japanese scholars have since corroborated his findings. Depression seems to have taken place after the elevated peneplain, which occupied the area, had reached a stage of mature dissection. The many islands of the Inland Sea are, then, the former mountain tops which have not been submerged. The descent from the Chugoku Mountains, as has been previously noted, is by many fault steps, whereas the mountains of Shikoku present a single, bold fault scarp along the median line between the Inner and Outer zones. Between this and the shore of the Inland Sea are the elongated and nearly parallel horsts of Yuzuru, Sanuki, and the Takanawa Peninsula.

Two distinct landscapes are encountered in the Inland Sea. The first is composed of the areas of open sea (*nada*) uninter-

[91] Penck, A., *Morphologie der Erdoberfläche* (Stuttgart, 1894), 2: 583–585.

rupted by islands. From east to west, these are Harima-nada, Bingo-nada, Iyo-nada, and Suwo-nada. They are regarded as the more depressed parts of the old, maturely dissected peneplain. The second landscape gives to the Inland Sea its world-wide reputation for beauty. Between the surfaces of open sea are areas in which almost countless islands are grouped. At first there appears to be no order within the grouping, but a closer observation of several of the groups shows that the islands occur in rows which are parallel to each other and to the major trend of the fault system of Setouchi. These rows of islands are separated from one another by narrow water passes, which, it is assumed, occupy fault lines. The island rows, then, are believed to represent the crests of submerged horsts. Step by step the summits of these nearly submerged horsts descend to the areas of open sea and finally disappear completely, so that the boundary between the island groups and the *nadas* is usually regular and is easily identified. This feature is particularly well developed on the boundary of Bingo-nada and the islands to the northwest.[92] The same condition exists between the Amakusa island group and the Yatsushiro Sea off western Kyushu. The sea, it is believed, occupies an extension of the Setouchi depression.

L. The volcanic region of central Kyushu rises out of, and almost completely buries, the western extension of the Setouchi Depression. Several kinds of volcanic landforms are found. The Kunisaki Peninsula in the northeast is composed of a maturely dissected, conical volcano. Slight submergence has taken place, and the lower portions of the many radial valleys now form inlets of the sea. The Yabakei district, in the west, is a dissected lava plateau whose surface has been altered by faulting.[93] In the south a cluster of lava domes is found, of which Mt. Kujyu (1,788 meters), by far the highest elevation in Kyushu, lends its name to the group. Mt. Aso is regarded as an unusually large shield volcano. A caldera of great size has been formed in the center.

[92] Kozu, S., and Nakamura, S., "An Explanation of the Hiroshima Geological Sheet on the Scale of 1: 200.000," *Imper. Geol. Surv. Tokyo* (1911).

[93] Kato, T., "Report of the Investigation of the Region in the Environs of Yabakei," *Publ. Earthquake Invest. Comm.*, 85 (1918).

Many cones occupy the interior, and among them Naka-dake is well known for the constant column of smoke it emits. Unzen-dake (1,360 meters) and Tara-dake (1,076 meters) lie to the west of the Ariake Sea. The former, the one farther south, has its top and flank dotted with many small lava domes. Numerous fault lines traverse the interior portions.[94] Tara-dake is a dissected conical volcano with many lava domes along its flank. The Island of Goto, off the western coast of Kyushu, is a basaltic lava plateau, which carries many cinder cones.

The northwest corner of the subdivision is dominated by a dissected plateau surface of basaltic lava. Submergence, after considerable dissection had taken place, has resulted in a coast line of extreme irregularity. Many of the embayments penetrate far inland. The marine cycle of erosion is still in a very youthful stage, indicating that the submergence was of recent date.

IV. THE OUTER ZONE OF SOUTHWESTERN JAPAN

The mountain system of the Outer Zone, which extends from central Honshu to the southwestern corner of Kyushu, displays a remarkable similarity throughout, both in geological structure and in morphological features. A zonal arrangement of crystalline schist and Paleozoic and Mesozoic sediments, in chronological order from north to south and of imbricate structure, characterizes its entire length. Flat-topped crests are rarely found, and none are of great extent. The system, as a whole, is definitely in a stage of mature dissection and is of high relief. The rivers are characterized by intrenched meanders and lack extensive flood plains, owing to the vigorous downward corrasion which is still going on. The accumulation of waste is almost negligible throughout the entire area except for short stretches along the Pacific shores. Normal erosion has been by far the most dominant factor in determining the secondary landforms.

This is the mountain system which Richtofen called the "Kuma-Kii Bergland." In spite of the fact that three straits divide it into four separate mountain areas, owing to down-

[94] Homma, F., "The Volcano Unzen," *Chikyu — The Globe*, 5 (1926): 64–66.

warping each mountain land displays a remarkable continuity within itself and with the whole. This is in striking contrast to the mountains of the Inner Zone. The mountain lands of the Kuma-Kii system are called, from east to west, Akaishi, Kii, Shikoku, and Kyushu, and are separated by Ise Bay, Kii Strait, and Bungo Strait, respectively.

As has been previously mentioned, the inner or northern margin of the Outer Zone is marked by a continuous fault scarp along the median line. The extreme eastern boundary is the bold fault scarp by which the Akaishi mountain land gives way to the lowland of the Fossa Magna. In each of the mountain lands the culminating peaks are near the top of the fault scarp which marks the northern boundary. Kita-dake (3,192 meters) and Akaishi-dake (3,120 meters) in the Akaishi, Bukkyoga-take (1,915 meters) in the Kii, Ishizuchi-yama (1,921 meters) in western Shikoku, and Sobo-san (1,758 meters) in Kyushu are all near the inner margin. As in the Inner Zone, the highest portion of the system is found near the Fossa Magna, from which there is a general decrease in elevation westward.

Each mountain land is regarded as a huge upwarped block, although the inner margin is dropped down along the high, continuous fault scarp which marks the northern limit of the Outer Zone. Only in the Shikoku subdivision is fault topography of significance in the interior. Here two rows of faults traverse the island, parallel to the median line, and produce fault scarps and valleys.[95] A few flat-topped ridges of small extent are found in each of the mountain lands. These are believed to be remnants of several levels of "Piedmontfläche" that have been formed in the course of successive upwarpings.

Signs of recent uplift are found in the marine terraces, elevated deltas, and dissected coastal plains which occur along the southern end of each mountain land. Northward, evidence of uplift disappears along the coast, and a shore line of rias type records the marginal downwarping which has separated the "Kuma-Kii Bergland" into four parts. The entire lack of volcanoes is a negative character of this mountain system.

[95] Tsujimura, as cited in note 11.

A. The Akaishi mountain land comprises the highest parts of the "Kuma-Kii Bergland." Like the mountain lands of Hida and Kiso, its northwestern neighbors, the maximum altitudes are near the top of the great fault scarp which delineates the Fossa Magna. These three mountain lands are frequently grouped into one topographic region and are called the Central Highland. Their locations and great altitude doubtless point to a direct connection with the formation of the fault scarp mentioned. The western margin of the Akaishi mountain land is marked by the Toyo Valley and its northward extension. This boundary feature is of fault origin and conforms with the median line.

The Akaishi, as a whole, is maturely dissected and of high relief. Flat-topped ridges are small in size and number. Kita-dake (3,192 meters) and several other peaks which exceed 3,000 meters lie in the north-central part and form the highest elevations. Small peneplain remnants have been reported from this locality.[96] From the highest part there is a gradual decrease in elevation southward until the mountain land finally merges into a band of low Tertiary hills on the southwestern periphery. These hills present an even sky line and have been regarded as a result of the dissection of a denudation surface.[97] Several erosion levels, in step formation, can be identified between the hill land and the higher mountains, but the initial surfaces have been almost completely destroyed.[98] The Tertiary hills were once covered by deep and extensive beds of gravel that was carried down by the rivers Oi, Ota, and Tenryu. The greater part of this depositional surface, however, has been eroded and the only remains are elevated deltas,[99] the greatest of which is the delta of Makinohara. Here the maximum height of the delta surface reaches 300 meters. This is 220 meters above the adjacent flood plain. An abrasion

[96] Tsujimura, T., "The Morphology of the Drainage Area of the River Tenryu," *Journ. Geog. of Japan*, 31 (1919) : 399–408, 461–468, 546–553.

[97] Yamasaki, N., "The Morphology of the Lowland along the Coast of the Province Totomi," *Journ. Geol. Soc. of Tokyo*, 12 (1905): 42–44.

[98] Watanabe, A., "The Geomorphology and the Geomorphological Development of the Southern Part of the Akaishi Mountain Land," *Geog. Rev. of Japan*, 6 (1930) : 730–736.

[99] Trewartha, G. T., "A Geographic Study in Shizuoka Prefecture, Japan," *Ann. Assn. Am. Geog.*, 18 (1928) : 127–259.

platform (50 meters) is attached to the southern tip of the elevated delta. Near the mouth of the Tenryu River a slight depression followed the dissection of the elevated delta, and the sea has invaded the wide erosion valleys. Lake Hamana is the largest of the several lakes in this vicinity which are due to this depression. The Bay of Suruga is characterized by a shore line resulting from the submergence of the piedmont line consequent to the downwarping of the mountain land. This shore line has since been simplified by the delta-building activity of the Abe and Oi rivers.

B. The Kii mountain land is of high relief and is in a stage of mature dissection. Bukkyoga-take (1,915 meters) lies in the north-central part of the area and constitutes the highest elevation. From this point there is a gradual descent in every direction, but a comparatively high altitude is maintained throughout. As a rule, high mountains occur even near the coasts, and steep slopes descend abruptly to the narrow coastal lands. Erosion levels have been reported from several localities,[100] but none are extensive. As the result of a recent statistical study of altitude distribution in the Kii mountain land, five steps of "Piedmontfläche" have been determined.[101] Little sedimentation has taken place. Even the larger rivers build but very small delta plains. The southern part is fringed by three narrow marine terraces in step arrangement. The maximum elevation is 80 meters.[102] Northward the shore is of the rias type and is the result of recent downwarping, which has drowned the maturely dissected land margin.[103] This downwarping must be only marginal, for there is no record of increased sedimentation or retardation of erosion in the interior. On the northeastern edge of the subdivision is the abrasion platform of Sakishima. A slight depression followed emergence and erosion,

[100] Wakimizu, T., "Mount Odaigahara," *Journ. Geog. of Japan*, 29 (1917) : 759–776.

[101] Miyasaki, K., "A Statistical Study of the Distribution of Altitudes in the Kii Mountain Land," *Geog. Rev. of Japan*, 6 (1930) : 1371–1384.

[102] Tsujimura, T., and Kawata, S., "Crustal Movement of the Kii Peninsula Considered from the Altitude Distribution of Coastal Terraces," *Geog. Rev. of Japan*, 6 (1930) : 1754–1767.

[103] Shimomura, H., "Some Considerations concerning the Coastal Terraces in Japan," *Geog. Rev. of Japan*, 6 (1930) : 850–874.

which has resulted in the deep penetration of the sea into the erosion valleys.[104]

C. The Shikoku mountain land presents the same general characteristics as do the other subdivisions of the "Kuma-Kii Bergland," except for the pronounced development, in the interior, of fault lines which are subparallel to the median line. The northern boundary is the bold, continuous fault scarp which towers above the Yoshinogawa graben and the Bingo-nada. Westward this fault scarp deviates from the median line and causes a fault coast along Iyo-nada. Tsurugi-yama (1,955 meters) is the highest point and is in the middle of a great elongated horst which is bounded by the interior fault lines mentioned above. Another prominent elevation, Ishizuchi-yama (1,921 meters), is located just at the top of the fault scarp which borders on the north.

The tips of the two southern peninsula-like projections of Shikoku Island are bordered by marine terraces. On the eastern projection the maximum elevation of any terrace is about 300 meters. Below this there are at least three terraces, in step formation, before the present coast land is reached.[105] The marine terraces of the western projection reach their maximum elevation of 80 meters near Cape Ashizuri. Northward, the coasts of the Kii and Bungo straits are characterized by submerged and sea-filled valleys. Although the coast line at the head of Tosa Bay is greatly simplified by the progradation of the Mononobe and other rivers, a peculiar type of submerged piedmont line is found. Here ridges and waste-filled valleys which are elongated are parallel to the shore line.

D. The Kyushu mountain land is of somewhat lower elevation than the other subdivisions of the "Kuma-Kii Bergland," but has the same general morphological features. The highest elevation, Sobo-san (1,758 meters), is just at the top of the fault scarp that joins the northern border. A few erosion-level remnants

[104] Tsujimura, T., "Coast Topography of Sakishima," *Chikyu —The Globe*, 3 (1925) : 85–100.

[105] Watanabe, A., "Preliminary Notes on the Coastal Terraces of the Southern Part of the Boso Peninsula," *Geog. Rev. of Japan*, 5 (1929) : 122.

have been reported, but, in general, mature ridges and youthful valleys are found. The intermontaine basin of Hitoyoshi has no duplicate in the entire Outer Zone.

The Sadowara coastal plain is in the southeast corner of the area. It reaches its maximum height of 150 meters near Miyasaki, in the south, where it attains its maximum breadth also. There is a gradual decrease in both elevation and width northward until the plain pinches out completely near Mimitsu. Farther to the north the shore is of the submerged type.[106]

E. The volcanic region of southern Kyushu occupies the depressed area lying within the semicircular fault line which marks the southern boundary of the Kyushu mountain land. This subdivision encompasses the southern end of Kyushu Island, including the peninsulas of Satsuma and Osumi. In this area there is an extensive lapillus plateau, which is in a youthful stage of dissection (Pl. XIV, Fig. 2). The volcanic detritus covers Mesozoic and granitic rocks which, in places, protrude well above the plateau surface.[107] Kagoshima Bay, between the two southern peninsulas, is a typical rift depression below the plateau surface. Three distinct steps downward can be recognized between the Kyushu mountain land and Kagoshima Bay, and volcanoes occur in three places.

The Kirishima volcanic group, which contains many small, youthfully dissected cones, lies at the base of the first step (Pl. XV). All of them have relatively large craters, a few of which are occupied by lakes. Sakurajima (Cherry Island, 1,118 meters), in the northeast corner of Kagoshima Bay, is a triple-cone volcano (Pl. XVI). It is no longer an island, since the eruption of 1914 was accompanied by a large effusion of lava which tied the island to the Osumi Peninsula. The southern end of the western or Satsuma Peninsula is studded with many volcanoes of recent origin. Kaimon-dake (924 meters) commands the entrance to Kagoshima Bay and is famous for its nearly perfect conical form. Locally, it is called the Satsuma Fuji. Lake Ikeda occupies a caldera depression, as does Lake Onami (Pl. XVII). A row of volcanoes extends

[106] Tsujimura, pp. 127, 128, 459–461, as cited in note 73.

[107] Hall, R. B., "Some Rural Settlement Forms in Japan," *Geog. Rev.*, 21 (1931) : 102.

southward from the mainland along the Riu Kiu (Loo Choo) Islands. Some of these are very active, and eruptions are of frequent occurrence.

Hills and low mountains of Mesozoic rock protrude above the ash plateau of the Satsuma Peninsula, and near the southern end of the Osumi Peninsula an extensive granitic mountain land occurs. It is characterized by sharp ridges and steep-sided valleys. Its highest peak is Inaho-dake (959 meters). This mountainous area is believed to be a depressed remnant of a mountain land of high relief, once much more extensive. The present steep cliff along the Pacific shore is regarded as a slope of subaërial origin which simply conforms to the present level of depression.[108]

CONCLUSION

The Japanese Islands are but part of the great circum-Pacific fold which was formed during Tertiary time. They are merely the summits of a mighty mountain system which skirts the Pacific side of the continent of Asia and are separated from it by the depression occupied by intervening seas. Between Kamchatka and Taiwan three major arcs may be recognized, each including, with the continent, a sea. As the Chishima arc embraces the Sea of Okhotsk and the Riu Kiu arc borders the East China Sea, so the central or Japanese arc embraces the Sea of Japan.

The islands of the central arc were subjected to tremendous upheaval and crustal disturbance. Mountain chains of varied formations have been uplifted to great heights above the surrounding seas. In general, the folding and upheaval conform to the major axis of the archipelago. Block-faulting has been almost constant since early Tertiary time and is still an important agent in determining the landforms. Wide areas of block mountains, variously tilted, are found in close proximity to upwarped dome mountains. Volcanic eruption has been exceedingly active, and many mighty cones tower above mountain land and plain. As a rule, the axis of the chains of volcanic mountains conforms to the general trend of the island arc. Some, however, cross it at right

[108] Tsujimura, T., "Coastal Topography of Japan," *Gendai-no-Kwagaku*, 8 (1918) : 131–143.

Fig. 1. The Karikachi Pass

Fig. 2. The Tokachi coastal plain from the edge of the town of Ikeda

FIG. 1. The Tatiyama Range from Kurihama on the Tayama Plain. Note the highly dissected fault scarps

FIG. 2. A view of the Japanese Alps. Note the col in the upper left-hand corner and also the development of cirques

Fig. 1. The Kongo Mountains from near Horyuji, Yamato Basin

Fig. 2. A valley in the lapillus plateau near Hagashiichiki, Kagoshima Prefecture

Tokachiho, a cinder cone, in the Kirishima group, Kyushu Island. Note the terraces in the foreground

PLATE XVI

Sakurajima from a point just north of Kagoshima City. The rift bay of Kagoshima is in the foreground

The crater lake of Onami, with Karakuni rising above, to the north

angles, as does the Fuji chain. Erosion has been unusually rapid in Japan, and the sculpturing in detail of the land surface has been great. The copious precipitation brought by the monsoons, the typhoons, and the continental lows give rise to a heavy run-off. The drainage divide is never distant from the sea, the slopes are steep, and many short streams descend rapidly to the sea, carving deep, V-shaped valleys.

The combination of these various agents has resulted in a most rugged surface and in a highly complex pattern of landforms.

The discussion of the 4 preceding major landform divisions, the 47 subdivisions, and the 196 districts does not by any means complete the study of landforms in Japan. It is merely a broad outline, incomplete in many respects, which will serve as a guide for more detailed study in the geomorphology and general geography of the Island Empire.

University of Michigan

THE MOROCCAN ATLAS: A STUDY IN MOUNTAIN GEOGRAPHY

ERIC PEARSON JACKSON †

TOPICAL OUTLINE

A mountainous geographic province

A barrier
- A climatic divide
- A physical barrier
- Passes

An example of geographic diversity
- The northern slopes
- The high valley of the Muluya
- The Saharan slopes

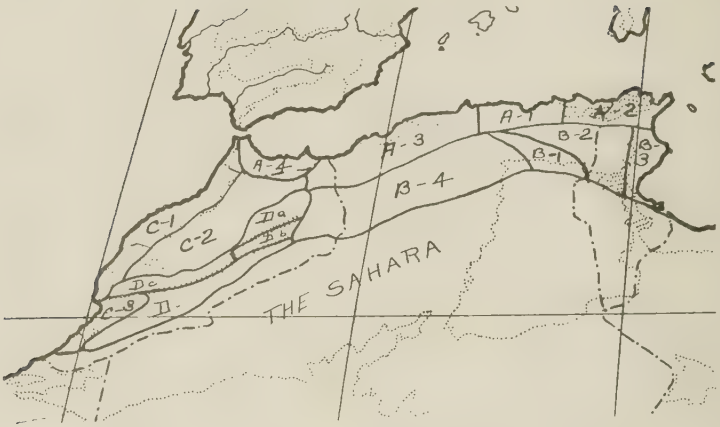
An isolating refuge

Summary

A MOUNTAINOUS GEOGRAPHIC PROVINCE

THE Moroccan Atlas is a rugged mountainous area, and its contrast with other parts of North Africa, as well as the general uniformity within the area, justifies its designation as a "geographic province." The Moroccan Atlas and the Rif, with their eastward continuations in Algeria and Tunis, form the Atlas system. This, which with all its ramifications constitutes the backbone of the whole stretch of the Barbary coast and northwest Africa, may well be considered a major geographic division (see Map 15). It owes its distinctive Mediterranean character to the climatic function of the Moroccan and Saharan Atlas, whose high bleak ranges keep out the continental desert influences. If it has been said that Africa begins at the Pyrenees it is no less true that Europe begins at the Atlas. The Pyrenees stopped the advance of the Moors as the Atlas stopped the advance of the Romans.

† Deceased June 11, 1930.



Map 15. The Barbary Coast and its geographic provinces

The Barbary Coast — a major geographic region

A. Hill and mountain country of Maghrab (after W. T. Chambers)
   - A–1. Kabylia
   - A 2. Eastern Tell
   - A–3. Western Tell
   - A–4. The Rif (in Morocco)

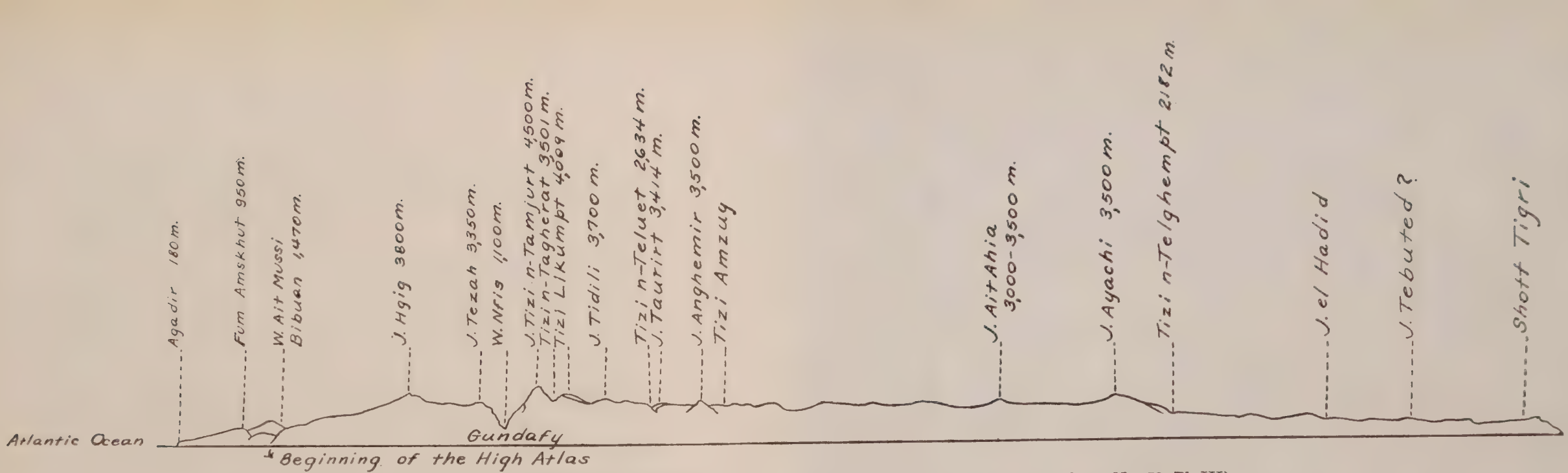
B. Intermontane Plateau and mountain country of Tunis and Algeria (after W. T. Chambers)
   - B–1. The Aures Massif
   - B–2. The High Plateau Province
   - B–3. The Sahel
   - B–4. The Plateau of the Shotts

C. Lowlands and plains of Morocco
   - C–1. The Atlantic Plain of Morocco
   - C–2. The Moroccan Meseta
   - C–3. The Sus Depression

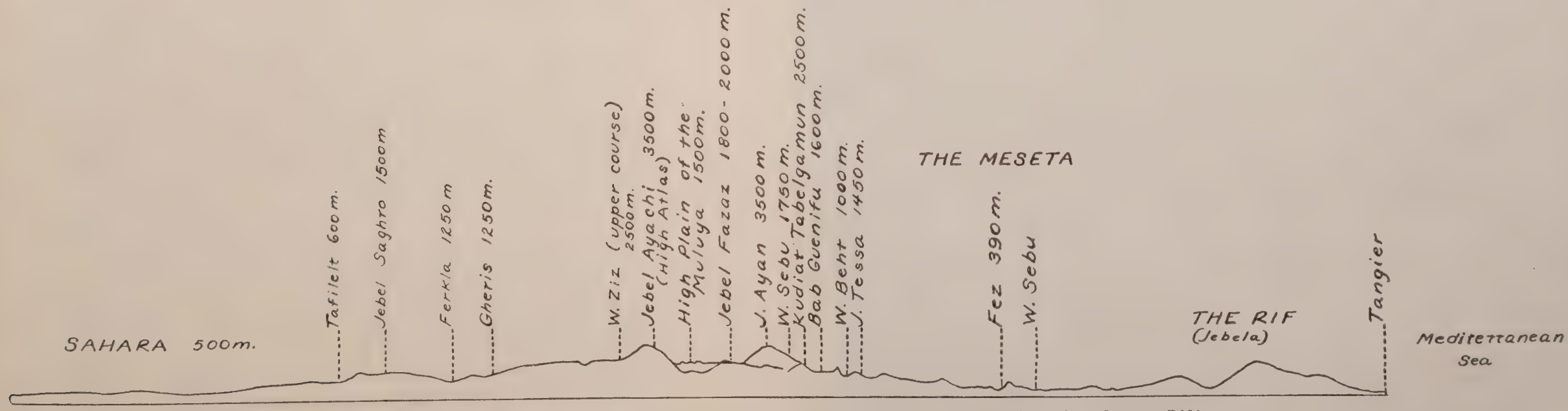
D. The Moroccan Atlas (a geographic province) and its districts
   - D–1. The Middle Atlas (plateaus and valleys on north slope)
   - D–2. The high interior valleys (including the upper Muluya)
   - D–3. The north slope of the High Atlas
   - D–4. The Saharan Slopes

Note — The Sus Depression, although structurally a valley in the Moroccan Atlas, is geographically one of the Moroccan plains.

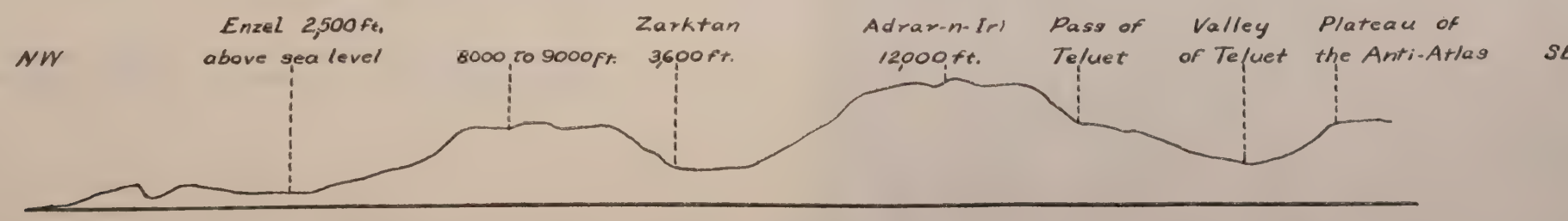
Another type of division of the section to the northwest of the Moroccan Atlas might be made, with river valleys as units, e.g. the Sebu Valley suggests itself as a good geographic area. Further study of the section is needed.



A. Profile from west to east following the crest of the High Atlas (adapted from *Ann. de géog.*, Vol. 10, No. 52, Pl. III)



B. North-south profile from Tangier to the Sahara by way of Jebel Ayachi (adapted from *Ann. de géog., ibid.*)



C. Profile from Tezert across the High Atlas (adapted from *Quart. Journ. Geol. Soc. of London*, 55 : 200)

FIG. 5. PROFILES OF THE MOROCCAN ATLAS

To the north the Tell and the Rif form typical hill sections. Between the Tell and the Saharan Atlas lies the semiarid Plateau of the Shotts, slightly overlapping the political boundary and extending into eastern Morocco.

In Morocco itself there is an interesting transition from the Atlantic coast to the Sahara, from the northwest to the southeast (see Map 15 and Fig. 5B). The first of the geographic provinces which may be distinguished is the Atlantic plain, with its river-mouth towns, fertile black soils, grain fields, and occasional forest areas — the section most open to European trade and influence and having within itself a geographic transition from north to south. Following up the river valleys we find ourselves in what has been aptly termed the Moroccan Meseta,[1] a region of grazing as well as agriculture, of nomadic Arabs and sedentary peoples. Near the base of the Atlas there is dependence on the mountains to supply conditions suitable for the orchards and crops. On the "piedmont" is the greatest density of population; here are the capitals of his Sherifian majesty the sultan, Fez, Meknes, and Marrakesh, as far away as possible from hated Christian influences and walled about as a protection against the warlike mountain Berbers. Finally, the Moroccan Atlas itself is a barrier and a transition zone separating effectively the plains to the north from the Saharan slope to the south and east. The Sus depression is in reality a longitudinal valley in the Moroccan Atlas, open to influences on the coast and sea.

The Rif is not to be included in the Moroccan Atlas. There hill country occurs which is essentially like the Algerian Tell. On the Rif there are heavier rainfall, denser vegetation, and little or no irrigation; on the Atlas the slopes are relatively bare, and the moisture is utilized in the irrigation agriculture that is extensively carried on. Furthermore, a denser population is to be found in the Rif, with a resulting pressure on the arable land available. Settlement has taken place on the ridges in the form of "perched villages," leaving the valleys and terraced slopes to cultivation.

[1] The term "meseta" has been applied to suggest the similarity between this region and the Iberian Meseta. See Gentil, L., *Le Maroc physique* (Paris, 1912), p. 4.

Only to a small degree does this situation exist in the Atlas. Migratory movements in connection with pastoral economy are less common in the Rif. From time immemorial the Rif has served as a place of refuge for the Berbers; the French and the Spanish can testify to the strength of their mountain fastnesses.[2]

The difficulty of presenting an adequate picture of the Moroccan Atlas is increased by the scarcity of data. As compared with the mountainous area in Algeria and Tunis, it has been penetrated but slightly by Europeans. Many sections, in fact, have never been visited except by the independent and warlike Berbers who inhabit the interior valleys, or by some rare traveler or scientist.

A BARRIER

A climatic divide

The Moroccan Atlas serves as both a climatic divide and a physical barrier. It separates a region where the Mediterranean type of climate prevails, with winter rains and summer drought and moderate temperatures, from a low-latitude desert, with decidedly continental influences. From the coast inland to the Atlas we find some climatic progression. The coastal region, the granary of Morocco, has moderate temperatures, with a relatively small range, diurnal and annual. The Meseta is a steppe region extending to the slopes of the Atlas, where there are greater extremes and a greater thermal range. The tempering influence of the ocean is not felt for much more than fifty miles inland. Even in winter at Marrakesh the daytime temperature may rise to 78° or 80° F. (26° to 26.7° C.), and the nighttime temperature may go as low as freezing. A change in the amount of rainfall also occurs. Eastward from the Atlantic there is first a gentle increase, then a more rapid decrease, with the average annual fall from fifteen to seventeen inches at Marrakesh.[3]

There also exists a latitudinal climatic progression. From a comparison of data of coastal stations one finds an appreciable decrease in rainfall and an increase in temperature from north to south. This is reflected inland by heavier vegetation on the Rif

[2] Blache, Jules, *Geog. Rev.*, 11 (1921) : 495–498.

[3] Knox, A., *The Climate of the Continent of Africa*, p. 38.

than on the Atlas, and by the increased dependence upon irrigation from north to south. The cold rains, which begin about the middle of October, are brought in by the prevailing northerly and westerly winds and continue to March. Such is the climate of the more heavily populated section of Morocco — essentially Mediterranean, yet with some diversity.

Beyond the Atlas barrier there is a striking contrast. In the northern Saharan oases extreme high shade occurs in summer in the daytime, with extremely low temperatures at night; in winter there are violent ever-changing hot winds, an exceedingly high rate of evaporation, and a negligible erratic rainfall that may do great damage where life is adjusted to areas of extreme aridity.[4] In the Zusfana and Saura region east of Tafilelt, noon-shade temperatures of 104° F. (40° C.) were recorded in February, 122° F. (50° C.) at the end of March, and 132° F. (56° C.) on April 9. Freezing temperatures at night were encountered in March, but not in April. Strong winds prevailed from all directions.[5]

The Saharan slopes present a different appearance, though the conditions are not truly those of the low-latitude desert. The ranges protect the Mediterranean region from Saharan influences, and the south and east slopes bear the brunt of the hot, drying winds, particularly of the well-known sirocco. Here is a desolate landscape, with slopes bare of vegetation, supporting only a little animal life adapted to the environment. There is a much lighter rainfall than on the north flank, yet greater than in the desert below. The *wadies* which collect the rains and melting snows support oases on the slopes of the Atlas.

The Anti-Atlas does not serve as a divide so effectively as do the High and Middle Atlas. It is lower, with a plateau-like aspect, and Saharan influences readily find their way into the Sus Valley. The *chergui*, a desert wind from the east in summer, is felt here.[6]

[4] Knox, *op. cit.*, pp. 78–79.

[5] *Ibid.*

[6] Goulven, J., *Le Maroc. Les Ressources de ses régions. Sa mise en valeur* (Paris, 1920), p. 120.

A physical barrier

As a physical barrier the Moroccan Atlas is also of tremendous significance. Since it separates regions of contrasted climate, products, and activities, all the routes that the landforms permit are used for trade and communication.

The Moroccan ranges, known by the Berbers as Adrar n-Deren ("Mountains of Mountains"), stretch as an unbroken wall from the eastern foothills of the Rif southwest for over nine hundred kilometers to Cape Ghir (see Map 16). This wall, with its essentially parallel series of four distinct ranges, presents a slight curvature toward the Sahara. This series comprises the main range (High Atlas), a lower and broader portion (Middle Atlas), a broad plateau south of the Sus (Anti-Atlas), and a line of hills bordering the desert (Jebel Bani [7]).

Passes

Separating the Rif from the Middle Atlas is the Taza Gap, the gateway from Algeria to Morocco. Through this wends the historic highway between the two countries, used of old by the Romans. "It is an essential passage." [8] Here the Wadi Innauen, a tributary of the Sebu, has cut its way headward through the *col* of Tuaha, forming a defile not more than four or five kilometers wide, flanked by mountains two thousand meters high,[9] and impeding road construction. A railway has recently been built to Taza from the Algerian side. Another obstacle which formerly

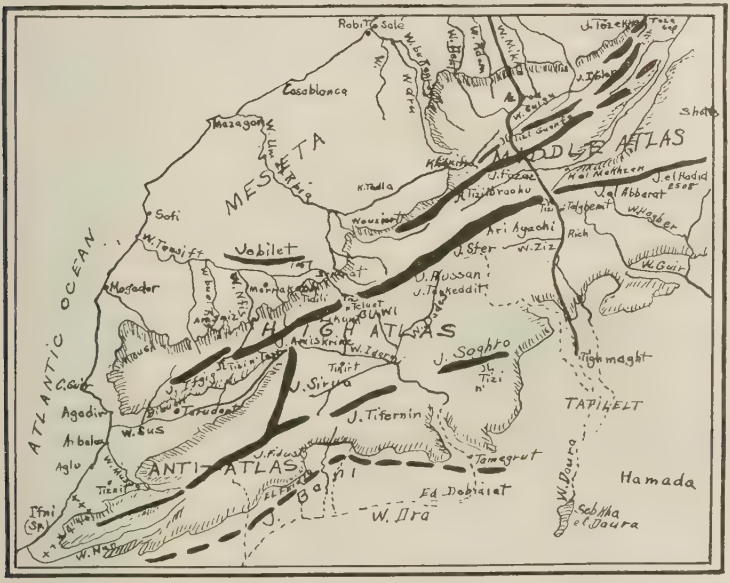
[7] The following native geographic terms may need explanation:
aït: "valley" or "valley people";
beni: "plateau" or "hill country";
jebel: "mountain" or "range";
tizi: "pass" or "*col*"; with n– meaning "to," e.g. Tizi n-Teluet = "pass to Teluet";
wadi: "river" or "stream" ("asif" is a local Berber term).

[8] Goulven, *op. cit.*, p. 113.

[9] De Foucauld, Vicomte Ch., *Reconnaissance au Maroc* (Paris, 1888), pp. 109–110. Vicomte Ch. de Foucauld was one of the earlier travelers in the Atlas (1883–84). His journeys included numerous districts never before visited by Europeans, and his book has served for many years as almost the sole authority for the geography (physical) of the Atlas. It embodies the result of careful surveys and contains a good collection of maps and sketches.

existed was the uncompromising attitude of the Rhiata tribe occupying the pass and surrounding heights. The towns, including Taza, situated on a point of vantage and fortified as well, are now held by the French.[10]

The least known section of the whole system, the Middle Atlas, is the broadest part of the barrier, by reason of its parallel folded



Map 16. Sketch map of the Moroccan Atlas

ranges (see Map 16). The main route from Fez and Meknes to Kasbet el Makhzen and the oasis of Tafilelt traverses the central section. Only French troops (since 1917) and a few travelers and scientists have followed the route.

From Meknes it goes south over the Tertiary plain and above the post of El Hajeb (see Map 17), ascends an escarpment ap-

[10] *Geog. Journ.*, 52 (1918) : 266. Also Commandant Poirmeur, "Renseignements coloniaux," *Afrique française*, Bulletin mensuel du comité de l'Afrique française et du comité du Maroc, No. 12, 1917.

proximately five hundred meters high to the Jurassic plateau of Beni Mguild — relatively level and but slightly dissected — past Ito and across the Tigrigra valley to Azrou, and south of here meets the route coming in from Fez. From Azrou across the folds of the Middle Atlas to Tamayust is a distance of fifty kilometers. Leaving Timhadit, in the upper valley of the Guigu, it passes through the narrow gorge of Taghzeft, then across the high plain of the Muluya to Midelt, thence to Kasbet el Makhzen, south across the lower eastern spur of the Jebel Ayachi (probably "Ayashi" would be a better spelling), a great bleak bulwark 3,750 meters in altitude, by the Tizi n-Telghemt, 2,182 meters, to Rich and Tafilelt.[11]

The traverse of the Middle Atlas is long, but the passes are not so difficult as those farther west in the High Atlas. The route crosses several of the high interior valleys separated by the mountain folds. It has undoubtedly contributed to the growth of towns or rather hamlets along the way, if indeed it is not responsible for their very existence. Each of these settlements has a vital location at the junction of routes, at the approach to a pass, or in the valley of a perennial stream at a turning point in the route. Azrou is a focal point for routes concentrating on a pass. Midelt is on the economic axis of the region; the natives from the southern oases come here to get the grain they need, and a Jewish *mellah*, "colony," has grown up as a result of trading.[12] Kasbet el Makhzen, the only settlement of any size, is in the middle Muluya Valley [13] (see Map 16).

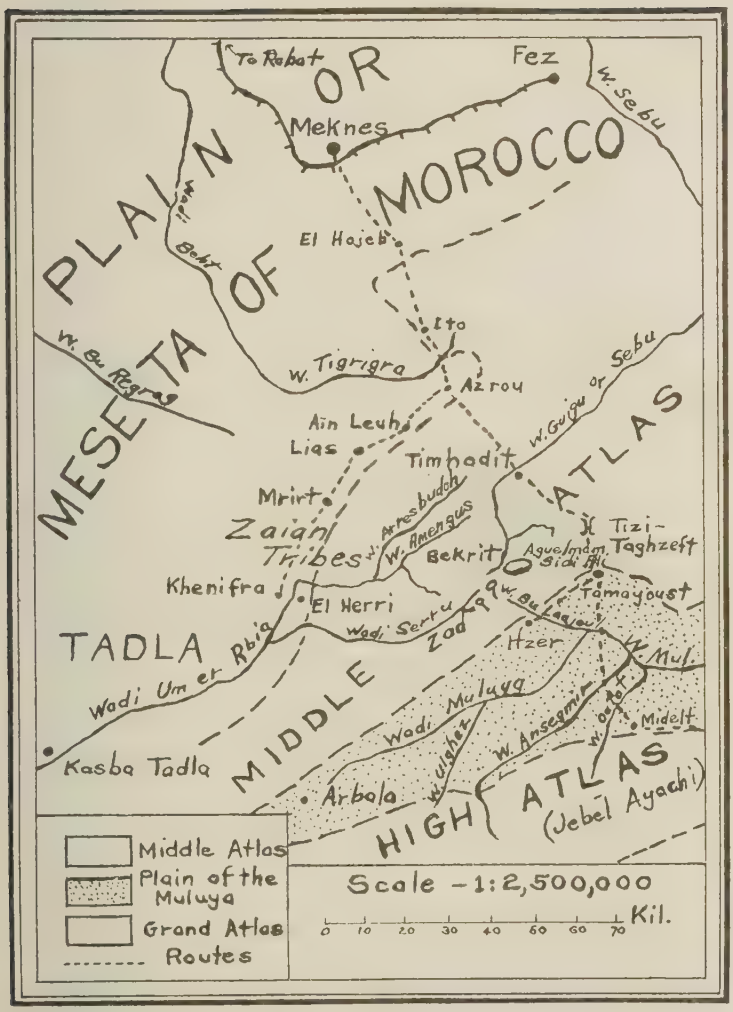
Minor passes in the Middle Atlas serve as means of communication, perhaps by herders, within the region from valley to valley.

The watershed separating the high valleys of the Wadi el Abid and the Wadi Muluya (col de Tirranimin) is described by Segonzac [14] as easily crossed from slope to slope in about an hour. The

[11] Blache, *Ann. de géog.*, 28 (1919) : 293–314.

[12] Blache, *op. cit.* [13] Goulven, *op. cit.*, p. 140.

[14] Segonzac, Édouard M. René, Marquis de, *Au cœur de l'Atlas* (Paris, 1910), p. 53. The Marquis of Segonzac in 1901 and again in 1905 made extensive exploration in the Moroccan ranges. He traversed the southern border after crossing the central portion of the High Atlas. He also explored in part the Middle and Anti-Atlas ranges.



MAP 17. Central section of the Moroccan Atlas, in the region of the high valleys (adapted from *Ann. de géog.*, 28 [1919] : 295)

Middle and High Atlas do not join, and this would suggest a relatively easy route. The Jebel (or Ari) Ayachi, however, forms a long, impenetrable barrier, recalling by its structure and appearance the chain of the Jura. Hence these upper interior valleys are off the main route of travel and trade, and are inhabited only by little-known native Berbers.

The High Atlas stretches for three hundred kilometers to the south and west, practically unbroken, to Tizi n-Teluet. Here the mountain wall is narrower than the Middle Atlas, but higher, with a particularly steep and difficult approach from the north. Flotte de Roquevaire's map shows no break in the whole stretch.[15] Numerous tributaries of the Um er Rbia to the north and the Wadi Dades to the south head back into the cols, too high and difficult for any practicable route. Such are Tizi or Rijimt, Tizi n-Terbula, Tizi Ayt Imi, Tizi Tarkeddit, and Tizi Amzug (see Map 16, p. 215).

The Tizi n-Teluet, which may be called the dividing point between the eastern and western parts of the High Atlas chain, is the most certain means of communication between the Meseta and the Sahara, especially since commercial relations have often been disturbed by Berber insurgents in the Middle Atlas,[16] to the south of Fez and Meknes. It is the main trade route from Marrakesh to the Dra country and apparently has been used for centuries.

From Marrakesh the High Atlas is to be seen across the plain, its high bare rocky summits rising above the forest vegetation, snow-capped for most of the year. There are scarcely any isolated peaks. It is a veritable rock wall. One leaves the plain for the foot-hills following up the valley of the Wadi Gadat, an affluent of the Tensift, which penetrates all the lower hills and cuts nearly across the center of the chain, forming the Tizi n-Teluet or Pass of Teluet and the basin of the Dra[17] (see Fig. 5 C).

[15] Flotte de Roquevaire, René de, "Essai d'une carte hypsometrique du Maroc," *Ann. de géog.*, 10 (July, 1901), Plate III. Flotte de Roquevaire, a member of Segonzac's expedition, made triangulation surveys of part of the western portion of the main Atlas, which have proved the best basis for the coördination of the work of previous explorers.

[16] Goulven, *op. cit.*, p. 103.

[17] Thompson, J., "The Geology of Southern Morocco," *Quart. Journ.*

At the confluence of the Gadat and another stream is the village of Enzel, important as a *sok*, "market," where the produce of the Dra and the Glawa country is exchanged for that of the region about Marrakesh.[18] Farther downstream Tazert serves as a focal point for routes from the plains to the pass. The way up the glen of Gadat and through the hill country is made difficult and dangerous by gorges and red-clay precipices.

From the top of the pass, to the south and stretching into the hazy distance, is a dull-gray and dirty-yellow expanse of undulating plateau dissected here and there by winding glens and wadies carrying the waters from the winter snows of the Atlas to the Dra. All this differs greatly from the view to the north over the scarry glens, forest-clad heights, and Moroccan plains.[19] Directly below, to the south, is the valley of Teluet surrounded by hills, an oasis in the melancholy expanse. Teluet is a focal point for routes leading from the Dra, from such neighboring regions as Moharram and Tifnut, and from the Sus and Gundafi. This valley and settlement illustrate the importance and power of the peoples in the passes. The *kaid*, "chief," holds sway here over much of Glawa.

Such is the Tizi n-Teluet, an important pass, yet more difficult for travel than the Tizi n-Telghemt in the Middle Atlas. The journey up the deeply ravined slopes and over the chain of bare rocky crests, through narrow, flanked-in valleys which are desolate refuges for vegetation and human life, is to be contrasted with the route through the Middle Atlas. One arrives there with extreme ease and crosses a massif composed of innumerable parallel mountains, many summits of which are wooded. Watercourses cut through the ranges and make possible relatively easy routes (e.g. Tizi Mrachu and Tizi Guenfa).[20] (Figures 5 A C show in profile the important passes of the Atlas range.)

Geol. Soc. of London, 55 (1899) : 193. Joseph Thompson, a geologist, conducted explorations in the central parts of the High Atlas (p. 188) and made several ascents of prominent peaks, though he failed to cross the main range.

[18] Thompson, J., *Travels in the Atlas and Southern Morocco*, p. 197. This is a popular account.

[19] *Ibid.*, p. 212.

[20] De Foucauld, *op. cit.*, p. 233.

The western section of the High Atlas continues southwest toward Cape Ghir and the Atlantic. North of Jebel Sirua, connecting this range with the Anti-Atlas, the mountain barrier changes its configuration, becoming broader and higher and more ramified. Some of the highest peaks of the Atlas occur here.

The principal route from Marrakesh to the Ras el Wed passes up the Wadi Nfis beyond Amsmiz through the valley of Gundafi (Gundafy or Gundafa) and over the Tizi n-Test, at the foot of the Kasbah Gundafi, called the "Pass of the Cats" because of the difficulty it creates for the traveler.

West of Ifguig the High Atlas drops down toward Cape Ghir, taking the form of a plateau, which continues west as Mtouga. The Atlas range ends some thirty miles from the coast.[21] Passage over this section is not difficult, and for many centuries trade has followed around this portion of the Atlas or through the Pass of Bibuan. Trade between Mogador and Marrakesh and South Morocco has focused on these routes.

The Anti-Atlas or Lesser Atlas, although having precipitous slopes, does not appear to be a very formidable barrier. From any vantage point in the High Atlas hardly a prominence appears to break the level of its summit, or a spur to jut from its sides.[22] It consists of several massifs (Jebels Fidust, Tizalmi, Iguan, and Taïrt), volcanic points emerging from a granite plateau but lower than the Jebel Sirua.[23] It forms a part of the Atlas barrier with respect to trade routes. The routes from Mauretania and the Sahara, passing between the sea and the mountains, are dominated by the fortified citadel of Tiznit. Twenty kilometers to the south at the foot of the Anti-Atlas is the oasis of Talaïut, which carries on trade to the southeast.[24] Formerly caravans traversing the area supplied Morocco with products from the Sudan in return for European merchandise. Today this commerce is reduced to an annual caravan which comes from Timbuctoo, and the trade of the Sus is limited and directed to the regions from Mogador and

[21] Goulven, *op. cit.*, p. 102. See also Thompson, "The Geology of Southern Morocco," *Quart. Journ. Geol. Soc. of London*, 55 (1899) : 192.

[22] Thompson, *op. cit.*, p. 344.

[23] Goulven, *op. cit.*, p. 107.

[24] Goulven, *op. cit.*, p. 128.

Marrakesh to the north and from the Wadi Nun and the Wadi Dra to the south. The chief outlet of the lower Sus is Mogador. The coastal route by way of Agadir is followed.

The plateau of the Anti-Atlas stretches eastward, continuously narrowing. Bending southward to the plain of El Feidja, then northeastward again, it separates this region from the large desert plain of Taruni, drained by the Wadi Idermi and its tributaries.[25] Heading back to the south the Wadi Aït Tigdi has developed a col, the Tizi Agni, which is followed by a route from Teluet via Tikirt and Tazenakt to the oasis of Tisnit (Agadir Tissint).

The conditions of travel over all these mountain routes are not of the best. Trails are steep and narrow; deep gorges have to be ascended; the wet red clay makes precarious footing; bridges are in poor repair or non-existent; streams that are subject to sudden floods must be crossed and recrossed; and in the higher passes snowdrifts often hinder travel. Roads, where they do exist, are in places bordered and cushioned with stone — they may actually be cut in the rock — and crude bridges are built over crevasses.[26]

AN EXAMPLE OF GEOGRAPHIC DIVERSITY

Not only is the Moroccan Atlas as a whole a geographic barrier, but also, owing to the contrasting physical conditions on the northern and southern slopes and the character of the landforms, there is great geographic diversity within the area. Furthermore, on the two flanks, Mediterranean and Saharan conditions are modified by elevation and ruggedness, transitional yet distinctive enough to make the Moroccan Atlas a "geographic province."

The northern slopes

To the north and west the mountain slopes intercept the winds from off the ocean and a year-round precipitation results, providing a forest cover and an abundance of running water in many sections. A large part of the rainfall, heavier than in the plains below, comes in the form of snow, which lasts for several months, especially on the summit zone of the High Atlas. Accompanying

[25] Goulven, *op. cit.*, p. 107. [26] De Foucauld, *op. cit.*, p. 73.

the precipitation is a decrease of temperature with the increase in elevation. On the north flank are forests of cedars on the intermediate slopes, summer pasturage in favored areas, abundant native animal life, and numerous dependable watercourses. There is a greater facility for non-irrigated agriculture here.[27] As one follows up the wadies and their tributaries across the plains, one finds adjustments to a rugged environment becoming apparent as the streams issue from the partly wooded glens and hills. Farther inward and upward are narrow valleys that run deep into the heart of the range. Frequently a ridge of foothills, a lateral feeder, or a bending of the headwaters of the stream itself, parallel to the great main wall of the Atlas, provides high, secluded, longitudinal valleys. Such is the valley of Gundafi, already mentioned. Berber tribes inhabit these isolated valleys, and their economic, social, and political life is well adapted to its harsh environment.

Up the valley of the Wadi Aït Mussa below Bibuan Pass the western end of the High Atlas rises from the coast in a series of rocky hills, beyond which lives the Berber tribe of the Aït Tub. Here and there on the slopes of the foothills, which are covered with coarse grass and scattered bushes, are perched villages.

Even a few glimpses show a geographic diversity in the High Atlas along the flank as well as from the lower to the upper valleys. The section back of Marrakesh, particularly the lower slopes, forms the richest portion.

The Shleuh (Berbers of the High Atlas) live only by agriculture. Barley, maize, and sweet potatoes are grown in valley bottoms, pushing up under the filbert, almond, olive, and aspen trees. The center of the olive culture of Morocco lies on the lower slopes of the Atlas from Demnat to Amsmiz, near the markets at Marrakesh and yet at a suitable elevation. Here we find perhaps three or four miles of trees, well watered. The little green fields, plantations of legumes, clumps of olive and occasional pomegranate trees, terraces where walnut and, especially, almond trees grow, all show intensive utilization of the soil and care in cultivation rather unusual for such a region.[28]

[27] Blache, *Geog. Rev.*, 11 (1921) : 492.
[28] Doutté, Edmond, *En tribu*, p. 139.

Grazing is carried on in some of the higher valleys in the west and becomes more extensive farther east. To the south and east of Marrakesh the poorer agriculturists have livestock in the mountain valleys. In the valley of the Wadi Tellus goats constitute one third of the flocks, which are seriously affected by the severe winter. Sometimes horned cattle are stabled in winter.[29]

Near the plain of Demnat a plateau zone drained by the head waters of the Um er Rbia connects the High Atlas with the Middle Atlas. Here are conditions that form a striking resemblance to those in the hill or tell country of the Rif. Near Wauziert [30] (see Map 16), on the slopes of the upper El Abid Valley, are numerous villages on crest lines overlooking fields and orchards in the valley, and the lower, frequently terraced slopes are cultivated in part by the aid of irrigation. Dispersed and square-storied houses flanked with bastions bespeak a pressure of population.[31]

A stretch of rugged limestone plateau flanks the folds of the Middle Atlas to the northwest. In the western part valleys have cut but a short way into the plateau. Here are permanent settlements, many of which have kept aloof from European influence by their hostility.[32] The rest of the plateau is rather desolate, dotted with thousands of small old volcanic craters and spotted here and there with thick patches of cedar forest.[33] Certain of these dry limestone areas furnish summer pasturage and a basis for transhumance. The Zaians winter on the Meseta from October to April, when there are heavy snows in the Atlas. Barley and wheat are cultivated, sometimes under irrigation, with occasional vines and fig trees. Then they resort to the Jebel, leaving the plain of Azaghar to the neighboring tribes. They live in *duars*, rectangular black tents set in circular formation, along the upper

[29] *Bull. de la Soc. de Géog. du Maroc*, No. 10, pp. 84–87.

[30] See also *Geog. Rev.*, 11 (1921), Fig. 16, facing p. 496, showing "perched" villages near fields and orchards in part cultivated by irrigation. Eastern slope of upper Wadi el Abid. Vertical view from airplane. Scale approximately 1:11,000.

[31] Blache, *Geog. Rev.*, 11 (1921) : 494.

[32] *Geog. Journ.*, 54 (1919) : 392.

[33] See Goulven, *op. cit.*, Fig. 10, facing p. 104, showing the Col of Tunfit in the High Atlas (photograph by Segonzac).

valleys, cultivate a little maize, and watch over their flocks, which graze on the upland vegetation and the undergrowth of the cedar forests.

The parallel folds of the Middle Atlas separate valleys, many of which are grassy strips flanked by cedar-covered hills where flocks graze. Chief of these is the valley of Selkart, entered by the Tizi Guenfa.[34] The eastern folds overlook the left bank of the middle Muluya Valley.

The cooler summer temperatures and the greater rainfall on some slopes give rise to a considerable forest vegetation on the northern flanks of the Moroccan Atlas.[35] A large part of the country has been cleared, but there is still a wealth of timber in some of the Atlas valleys. Large conifers of ten- or twelve-foot girth are not uncommon. Ball concluded that the "mountain Flora of Marocco is a southward extension of the European temperate Flora, with little or no admixture of extraneous elements, but so long isolated from the neighbouring regions, that a considerable number of new specific types have here been developed." [36] These include the *arar* (a native juniper), the almond, and the *argan*, a sapotaceous tree bearing olive-like fruits (confined to the Sus and to the western High Atlas).

On the broad plateaus and ridges of the Middle Atlas the forests are well developed and the zonation is easily traced. Two zones have been recognized, the first ending about ten kilometers to the north of the Guigu, and the second extending south from Timhadit to Jebel Ayan Haiane and the Muluya. The forests of the Atlas are of some economic importance; the cedar and the oak are especially abundant.

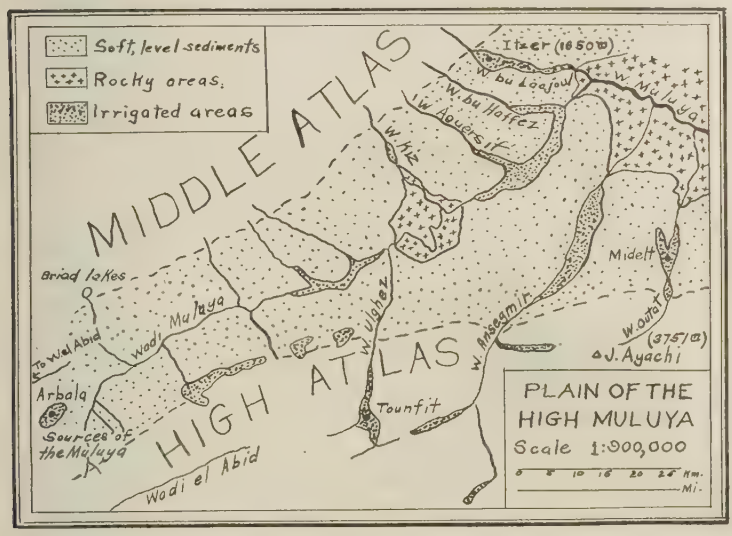
[34] Goulven, *op. cit.*, pp. 105–106.

[35] At Timhadit the average temperature for summer is between 24° and 30° C.; for winter, between 3° and 4° C. No figures seem to be available to show the higher precipitation in the mountains. With increasing elevation a greater proportion of it is in the form of snow. Snow remains on the mountains above 1,500 m. Sixty-five cm. has been observed at Timhadit (elevation 2,000 m.), and 70 cm. at Ito (1,450 m.).

[36] Hooker, Joseph D., and Ball, John, *Journal of a Tour in Marocco and the Great Atlas* (London, Macmillan and Co., 1878, p. 445).

The high valley of the Muluya [37]

The high valley of the upper Muluya lies between the Middle Atlas and the High Atlas (see Map 18). Geographically this interior valley is a transition zone. Environmental conditions of the north and south overlap in this high inclosed area. Descending



Map 18. Plain of the upper Muluya (adapted from *Ann. de géog.*, 28 [1919] : 307)

the slopes from the inner range of the Middle Atlas one finds the same succession in the vegetation, first cedars and *arars* mixed

[37] The region of the Jebel Ayan (see Map 17), northeast of Khenifra in the first fold of the Middle Atlas, is of considerable interest as being the *château d'eau* or hydrographic center of Morocco. It is a region of mountain lakes, low in summer and filled in winter, near which most of the principal rivers have their sources. The Muluya, the Guigu (called the Sebu downstream south of Fez), the Um er Rbia ("Mother of Grass"), the Dra and the Ziz all rise within a comparatively short distance of one another. The Wadi Bu Regreg descends from the Zaian chain (Jebel Arrar and Auan). The Wadi Beht (known in its upper course as the Tigrigra) and the Wadi el Abid, large tributaries of the Sebu and Um er Rbia, also rise here. Farther to the southwest

with live oaks, which give way with diminishing altitude. Here and there are maples and the pistachio trees of the Atlas (Betums).[38] The lower slopes are bare except for an occasional line of hills or valley sides that may have a scattered growth of junipers.[39] Tributary streams flow down from gorges and the ravined slopes to join the Muluya, which winds through a remarkably level plain of recent geologic sediments. The streams seem hardly to have furrowed its surface.[40] The southern tributaries drain the great austere Jebel Ayachi which hems in the valley on the south. Rising two thousand meters above the valley floor, it is utterly devoid of vegetation, its desolate gray color is broken only by occasional patches of white snow in the sags of its crest line, from which the streams below are fed. Its lower slopes are a series of rock terraces, sharply ravined here and there by the headward cutting of these wadies. From north to south and from west to east in this valley the transition to greater aridity progresses.

Settlement follows the course of the Muluya and its tributaries, being entirely dependent upon irrigation. Cultivation appears as ribbon-like stretches from one hundred to five hundred meters, broken by rocky areas in the valley. The square *kasbahs*, "fortified settlements," and *ksur* are located on some eminence or crest overlooking their own little garden spots. Culture and settlement find more favorable conditions on the tributaries than on the main stream. Here the water supply is most dependable, and settlements are near the alluvial fans where the streams leave the ravined slopes. The location of the cultivated areas also shows that the right bank is more favorable, probably because the waters

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the Tensift and its tributaries receive the waters from about two hundred and eighty-eight kilometers of the High Atlas. The Sus drains the opposite slope as well as the Atlas.

[38] Bernard, A., "Les Forêts de cèdres de l'Atlas marocain," *France-Maroc* (Dec. 15, 1917), p. 3.

[39] See *Geog. Rev.*, 11 (1921), Fig. 17, facing p. 498, showing in the plain of the high Muluya an oasis on an alluvial fan, where a gorge opens out upon the plain a little to the north of Itzer. Two *ksur*, "fortified villages," may be distinguished on the nearer and farther edges of the fan. Scattered vegetation. Altitude of airplane, 3,500 meters.

[40] *Geog. Journ.*, 54 (1919) : 392.

from the melting snows of the Jebel Ayachi are more abundant than on the opposite slope. The smaller valleys not well enough supplied with water are devoid of habitation. The water is usually collected in *seguias*, "reservoirs," and distributed by irrigation canals.

There is little water in the Muluya itself, owing in part to aridity, but in a larger measure to its use by the natives of the upper tributary valleys. Little rain occurs in the high valleys, but there is a snow cover in winter.[41] Fords are numerous on the Muluya and easily passable, and the stream itself does not appear to be able to feed irrigation canals at distances shorter than twenty-kilometer intervals.

The interstream flats with a soft yellow sedimentary covering are little used; occasionally a sparse vegetation provides sufficient food for grazing. In the valley of the Wadi Kiz shepherds and their flocks have been seen.

The upper Muluya Valley, the different levels of which are separated by rocky gorges, is nearly one hundred kilometers in length. At Midelt, where its width is about forty kilometers, the valley is better known because the main caravan route from the narrow gorge of Tizi Taghzeft crosses here, going by Midelt and Kasbet el Makhzen to the Tizi n-Telghemt.

The Muluya Plain narrows to the southwest to about fifteen kilometers. It is a little-visited region, and settlements have been seen only from the air. The valley is not a *cul de sac* in the Atlas, for there is an easy divide to the Wadi el Abid, but it is simply a longitudinal valley not traversed by main routes.

The upper valley of the Wadi Utat differs geographically from the northern flanks of the Atlas. It is located to the east of high ranges with arid conditions [42] and few oases, and there is a greater resemblance to the situation that exists along the courses of the Saharan wadies. Yet, owing to altitude, these mountain oases have a distinctive aspect. The winters are too severe for the

[41] Goulven, *op. cit.*, p. 109.

[42] Owing in part to the drying effect of the *chergui*, an east wind blowing into these upper mountain valleys, and to the sirocco, the southeast desert wind, which arises in connection with a high-pressure area forming to the extreme south and sometimes in the Atlas itself.

growth of trees.[43] The date palm of the desert, the fruit trees of the lower slopes, and the walnut of the higher slopes are absent.

To the east the middle Muluya Valley extends from Kasbet el Makhzen, the crossing of the route from Fez to Bu Denib, for some one thousand five hundred meters in a northerly direction to a *kheneg*, "gorge," between the Middle Atlas and the Gada of Debdu in the Tell Atlas. This valley is about thirty kilometers long and is walled in by the Middle Atlas to the west and the long slope of the Rekkem to the east. It is a large plain partly covered with thorny tamarisk, and supports scattered flocks. In the valley, chiefly along the main stream, there are several oases with irrigated gardens and fruit trees. A few oases are to be found up on the slopes of the Middle Atlas. Because of decrease in altitude and the resulting geographical changes, the middle Muluya Valley is considered transitional to the high plateau to the east. This is the western end of the Plateau of the Shotts, which lies within the political boundaries of Morocco. It extends from the tell country and the Wadi Za, a tributary of the Muluya, on the north to the Sahara, with which it gradually merges, on the south. The Jebel Abbarat, the Jebel Hadid, and the Jebel Hamada are low plateaus connecting the Jebel Ayachi with the Saharan Atlas, and serve as the watershed between the Wadi Charef and the Wadi Guir. The Plateau of the Shotts is a steppe region with some *alfa*, a species of esparto grass, and the large more or less temporary lakes, resulting from interior drainage, which we know as *shotts* or *sebkas*.[44]

The trade of eastern Morocco concentrates on Udjda on the Algerian frontier. There are rail connections with Taza, and overland caravans to Tafilelt, Zusfana, and the Saharan oases cross the Plateau of the Shotts via Debdu and Berguent. Relatively little trade seems to follow the Muluya Valley.

[43] At Timhadit temperatures as low as − 9° C. in December and − 11° C. in March have been recorded. Segonzac experienced similar conditions at Azercur in the high Muluya Valley.

[44] Goulven, *op. cit.*, pp. 137–138.

The Saharan slopes

Geographically the Saharan slopes of the Atlas grade off with descending elevation to the great desert to the south. The desolate wind-eroded slopes, hills, and plateaus are broken only by wadies. At favorable sites in the valleys there are very rich oases which provide the water necessary for life. Moreover, the valleys serve as the routes for travel, trade, and nomadic movements. The character of the oases changes as the three great wadies with their affluents, at first perennial streams, flow down and lose themselves in the sands of the Saharan Plateau.

The Guir drains the eastern part of the Saharan slopes of the Atlas, with its source not far from the Muluya in the Jebel Abbarat. Known as Aït Aissa here, it cuts its way southward through gorges to the plain of Duiret Seba. Another tributary farther east traverses this rugged plateau country (connecting Jebel Ayachi with its eastern counterpart, the Saharan Atlas) in a similar way. These gorges serve as natural gateways from one region to another. The water supply, however, is irregular. In summer it hardly suffices for irrigation needs; in the rainy period (October to April), owing to melting of the Atlas snows, as well as lack of a forest cover, devastating floods are frequently experienced. Dams are built which serve to supply the cultivated gardens and fruit trees which surround the *ksur*.

In the little alluvial basins in this rugged region there are carefully cultivated fields and a fairly dense population in the picturesquely located *ksur*. Beyond Bu Anan the plains increase in size and the wadi reaches the true Sahara. Its lower course is for the most part uncultivated, and only in times of flood does it continue south, spreading out in the El Bahriat (a *petite mer*); then with its affluents the Bu Dib and the Zusfana it is lost in the Saharan sands in the Saura region.[45]

The source of the Wadi Ziz, likewise, is on the slope of Jebel Ayachi. Flowing east through narrow gorges at the junction of its first tributaries, the Wadi Sidi Hamza and the Wadi Nzala, it is crossed by the route from Fez via Tizi n-Telghemt to Tafilelt

[45] Goulven, *op. cit.*, pp. 153–154.

and the upper Guir (Bu Denib). The stream then swings south, bordered by cultivated areas of barley and maize, and leaves the last flank of the Atlas by a *kheneg*. At this gateway to the Sahara (at the oases of Tamerrakecht and Ksar es Suk) is the junction of the routes from Tafilelt, following the valley of the Ziz, and the route from Bu Denib and the Guir, following in part the valley of the Wadi Aït Asseri.[46]

The Ziz, with the Wadi Gheris, forms an intermittent stream which flows through the Tafilelt district, one of the richest regions of Morocco, with its date palms, villages, and *ksur*. Finally, it is lost in the *sebka* of Saura among the dunes of the Sahara.[47]

The Jebels Tifernin and Saghro of the eastern Anti-Atlas, the Jebel Sirua, and the High Atlas inclose a basin-like plateau cut by the Dades and Idermi, the upper valley of the Dra. The Dades, draining the Jebel Saghro and the High Atlas, is bordered with villages and joins the Idermi at the Kheneg Targa. The Idunil, Iriri, and Imini drain the Jebel Sirua and unite, forming the Wadi Idermi. In this valley walnut, fig, and olive trees thrive, and there are numerous *ksur* with from two hundred to five hundred inhabitants. Water never fails, for the river is thirty to forty meters wide and is very deep.

The middle Dra Valley is a long and fertile oasis, among the richest in Morocco, with flourishing date palms and many villages.[48] Near Tamegrut is the meeting point of routes over the Atlas to Marrakesh, east to Tafilelt, west to the wadies Nun and Sus, and south across the desert to Tuat. At Fum Takkat the Dra cuts through the hills of Bani,[49] where they serve as a natural dam to provide water for the drier valley to the south.

The Dra, often dry now, swings parallel to the Atlas toward the Atlantic through stony desert plains like that of El Feidja.

[46] See *Geog. Rev.*, 11 (1921), Fig. 11, facing p. 492, showing *kasbahs* in palm groves, vicinity of Bu Denib, Saharan slope of the High Atlas.

[47] Goulven, *op. cit.*, p. 152.

[48] De Foucauld, *op. cit.*, p. 268.

[49] The hills of Bani are structurally an outlying orogenic fold of the Atlas system, extending from the Atlantic to Tafilelt (Map 16). Less than two kilometers in width, these hills stretch out for over two hundred kilometers in length. They rise above the desert for from two hundred to three hundred meters.

The long depression of Ed Debiayat is filled with water in the spring, when there is abundant vegetation and a rich harvest. Occasional gum trees are scattered along the valley. Several small tributary streams, for the most part intermittent, drain the Jebel Bani and the Anti-Atlas. Tissint is famous for its dates, and Tatta and Akka were ancient centers of commerce. The Dra finally reaches the Atlantic seventy kilometers south of the Nun.[50]

The whole slope of the Atlas here is submissive to Saharan influences. Extreme temperatures and a scarcity of vegetation result. The oases are garden spots in the midst of desolation. A sedentary life is the rule, though pastoral nomadism does play a part.[51] The well-watered mountain valleys with cooler temperatures support cattle and goats; the pasturage of some of the high plateaus maintains herds of camels in the summer, and the *hamada*, "desert," plains near the lower wadies serve in winter.[52]

It is not only difficult, but also unnecessary, to determine precisely where the Atlas ends and where the Sahara begins, so gradual is the transition. The zone where the wadies become intermittent, where the routes have to focus on the *khenegs* in the Anti-Atlas, and where the date palm comes into its own is probably the best criterion.

The features of geographic diversity of the Atlas bring out clearly the main facts of the economic geography of the area. In the higher isolated valleys or in the more poorly favored sections the economy is more nearly self-sufficing. But the Atlas is not without exterior trade relations. First, there is the trade using the pass routes; dates and fruit or gum from the oases, and products from farther afield are carried across the Atlas or are exchanged for grain, cloth, arms, or other commodities that are desired at some trading point en route. Statistics on the considerable trade crossing the Sahara are not available. Then there is the trade from the region itself. The southern part is more

[50] Goulven, *op. cit.*, pp. 151, 155. The Dra is the longest river in Morocco, being about twelve hundred kilometers. Its value fluctuates with the seasons.

[51] See *Geog. Rev.*, 11 (1921), Fig. 12, facing p. 492, showing vertical view of a *kasbah* in detail. A diagram might well be made showing outline of building and layout of orchards and irrigation fields surrounding it.

[52] Goulven, *op. cit.*, p. 158.

nearly like the Sahara, so that the trade on the northern slopes is of more importance where the contrast between mountain and plain is more marked. The olive, the *argan*, goat's hair, honey, wax, timber, charcoal, cattle, and even milk are in demand and markets have been established (e.g. at Demnat and Amsmiz).

The exploitation of the mineral resources of the Atlas Mountains is in keeping with the simple economic status of the natives. That mineral deposits of some value do exist appears quite certain from the accounts of travelers and the reports of natives, as well as from geologic deductions. Salt is a most necessary mineral product, and its exploitation will be pushed even in the early stages of mining. In some valleys (e.g. Urika) in the High Atlas the natives, despite primitive methods, manage to furnish enough for their own use. Rock salt is mined by the natives of the upper Guir Valley. Copper has long been mined near Tarudant in the Sus. The High Atlas has been partly prospected (by Thompson and others), with many favorable reports. The Gundafi region, where the natives have mined silver, is especially rich. In the valley of the Nfis iron is mined in some quantity, transported, and sold in various forms.[53] The Aït Haddidu, at the foot of the Jebel Ayachi to the south, exploits veins of galena, iron, and lead, and there are reports of the existence of other metals.[54] Iron and zinc are said to occur in the upper Guir, and several travelers have seen antimony on the southern slopes of the Atlas.[55] Mineral resources may play a more important part in the geography of the Atlas with the development of European exploitation.

The Moroccan Atlas, then, is transitional between Mediterranean Africa and the plateaus and deserts of eastern and southern Morocco. By reason of elevation and its barrier nature it not only possesses a certain unity, but also plays a definite part in the life of all Morocco. It is a complementary province. This relationship is most marked on the north, where the geographic contrast is the strongest.

[53] Piquet, Victor, *Le Maroc* (Paris, 1918), pp. 104–105.

[54] Goulven, *op. cit.*, p. 113.

[55] Gerhard Rohlfs made the first detailed exploration in the Moroccan Atlas, in 1861–62.

AN ISOLATING REFUGE

The Berbers long ago sought a refuge in this mountainous area, and the isolating influence of the valleys and oases into which they moved is reflected in the characteristics of their political and social life.

The Berbers (known locally as the "Amazigh") are the most numerous and important of the races inhabiting Morocco, and their blood permeates the whole population. They are the direct descendants of the aboriginal people who thrice conquered Spain. The "Moors" of the plains are for the most part Arabs with some Berber blood, introduced in the eleventh and twelfth centuries.

The Berbers have virtually maintained their independence in the Moroccan Atlas.[56] These warlike people have never been completely subjugated by the sultans, nor do they pay the imposts. The lowlands form the *bled el-maghzen*, "government country," furnishing the sultan's bodyguard and the garrisons, whereas the mountainous regions are the *bled el-siba*, "unsubmissive country."

The forests of the Atlas have helped to protect the Berber in his refuge. Much of the mixed-oak forest which originally covered the plateau in the Middle Atlas near Azrou was destroyed by Mulay Hassan to rid the country of brigands.[57] A strong hostility accompanies their feeling of independence. Few Arabs, except occasional religious teachers, venture far into the mountains. It has been extremely perilous for Europeans to go into the Atlas, though it is safe to travel unguarded on the plains. In the mountainous districts it is the custom to be accompanied by a mounted *makhazni*, "policeman," whose duty, however, is as much to prevent exploration as to afford protection. In recent years the

[56] The whole Atlas system has served as a refuge for the Berber element, but the Moroccan Atlas has always been the least known and the most isolated section. Even the Maritime Atlas (Tell and Rif) was well known to the Romans, but their empire never reached beyond the Wadi Regreg. The ancient caravan route from the province of Mauretania to western Sudan crossed the lower Middle Atlas by the pass of Telghemt beyond the oasis of Tafilelt, then known as Sajilmassa.

[57] Piquet, *op. cit.*, pp. 58–59.

French penetration has made it easier for travelers to go into the region,[58] but it is by no means under direct control. A few scattered posts have been established, though for the most part the French have simply won over the support or allegiance of the local Berber chiefs.

The differentiating function of the mountain environment is seen in the preservation and intensification of the feudalistic régime. The Berbers are not town builders, but live in villages in isolated mountain valleys. A single village or group of villages in a valley forms the unit of government. The villages are the units of state and are independent with regard to internal affairs. Loose confederations of neighboring groups often exist. On the southern slopes inhabitants of the oases act together through *canouns*, "agreements," for the distribution and use of irrigation water. On the north slope settlement tends to concentrate in the main valleys, and in some places such a section is under a more or less unified control. "Wauziert is the chief place and market of a mountain canton, situated at the bottom of a valley in which it is the most elevated agglomeration." [59]

The *kaid* is the chief and his authority is strong, although it is based on the confidence of his followers. The richest garden is his, as is the greatest wealth. Military service is necessary for protection and for skirmishes with other tribes. The *kaid* may delight in exhibiting his power to the traveler by a display of the prowess of his horsemen with their long firearms. The great *kasbahs* add the final touch of feudalism.

As is typical in a mountain environment, these people are highly sedentary. The semiarid conditions on the plains below make the contrast more striking, for there, except in the towns, life has a seminomadic character. On this their social structure is built. Such a mountainous environment provides a unique opportunity for conservatism as well as individualism. In their life, customs, racial characteristics, language, and religion we find survivals of peculiarities.

[58] E.g. the French Alpine Club in the spring of 1923 visited a section of the High Atlas south of Marrakesh.

[59] Blache, *Geog. Rev.*, 11 (1921) : 502.

Their buildings are well adapted to the environment. The villages present a substantial appearance; most of the houses are constructed of untrimmed stone, which of course is abundant. In some sections huts are of turf, or of clay tiles with mortar made from lime and clay or cow dung. The houses are roofed mostly with reeds, straw, stones, or clay. The material used in construction depends upon its availability. Cattle or mule stalls are near the living quarters, and to a European the vermin-infested dwellings are repulsive. Travelers usually prefer to camp outside. Irrigated gardens and fields of grain surround the houses. A readily defensible site is chosen, or else some artificial protection is provided, such as a bank or stone wall or hedge. With pressure of population storied houses are sometimes built, with part of the upper story forming a rough veranda. In the colder sections the natives may spend the winter in a vault beneath. Sometimes in higher altitudes and in exposed positions the houses are built close together for protection from the wind.

To a large degree there is a self-sufficing economy among these people, in conformity with their surroundings. Irrigation agriculture, with some grazing, is the basis. Terraces are laboriously constructed; primitive methods of cultivation and irrigation are used. Among the Zaians each cultivator in turn has his water from the *seguia.* Often in the favored areas a whole tribe is engaged in some activity — the cultivation of some agricultural product, the gathering of some forest product, or a little mining or grazing. There is dependence on hand labor, and skill and intelligence have been developed in many ways, such as running olive presses and crude flour mills, making domestic utensils and implements, woodworking, weaving and dying, tanning and dressing of leather, making oil and soap, and pottery. These all show the craftsman type of activity. The Berbers are skilled in the use of stone and lime and tiles, and are often engaged as builders by the Arabs. They have millstone quarries in the mountains. Mines are worked, particularly for salt, iron, lead, copper, and silver. Frequently individuals have a pride and special ability in some particularly delicate craft, such as the working of silver, or wood carving.

The Berber women are more fortunate than their Arab sisters,

owing to the more democratic life and the definite part that they play in this economy. Most of them go unveiled. To them fall the household labor and the weaving of the typical flowing garments — the *bornus*, the *khenifs* of wool or goat and camel hair, and the *farhalt*, "streaked cloak." Embroidered wool mats are twisted. Among the Zemmur, Zaian, and Beni Mguild tribes of the Middle Atlas highly esteemed carpets of an excellent grade of fleece are made.[60] Sometimes the women have property rights and some voice in the government. Rohlfs states that in southern Morocco a Berber religious corporation, the Savia Kartas, was ruled over by the chief's wife.

How much the Berber race may have become differentiated in its mountain habitat is hard to determine, though such a tendency would seem inevitable. In some high valleys farther east there is evidence of the development of blond variants from the usual dark Hamitic type.[61]

Indications of Negro blood are found in this region, due presumably to intermarriage of Berbers with slaves from the Sudan. Members of no other race enter into the life of this region except Jews who are engaged in trading. They live in *mellahs* attached to the villages. Each trader has his master among the native chiefs. They speak a corrupt form of Arabic. Several of the so-called Berber tribes are thought to have been of Jewish origin, and to have been converted when Islam spread over the region.

The spoken dialects of the Berber language have become quite differentiated in this environment. In part this may be attributed to a lack of literary standard. The tongue preserves many of the forms of an ancient language, and but little is known of the writing. Arabic is spoken on the plains, and it is interesting to note the difference in the geographic terms when one enters the mountains. In many cases the lower courses of the streams have names different from those of the headwaters.

The social structure of the Arab is built on the Koran, which inculcates absolutism, aristocracy, and theocracy; the democratic Berber is but a nominal Mohammedan. He has his unwritten code

[60] Segonzac, *op. cit.*, p. 130.
[61] Semple, E. C., *Influences of Geographic Environment*, p. 39.

and thereby expressed his individuality in contrast to the hereditary caste. The religious observances of the Moslem are not always adhered to strictly. One sees a reflection of the environment in the fact that he pays greater reverence to the local saints. Villages sometimes have their own saints and prophets, and in many cases this lead to feuds. Old religious customs are preserved, too, even certain Christian and Jewish usages of pre-Islamic days.

The land, then, has served as a stronghold for the Berbers and has differentiated them politically and socially.

SUMMARY

The Moroccan Atlas is a high mountainous area, physiographically young and rugged, stretching for over nine hundred kilometers, nearly the entire length of Morocco. As a geographic province it plays a part in the Moroccan life in directing travel and trade over its pass routes and in its hydrographic function of supplying water, which is the basis for human existence on the lands below, especially to the south, where there is greater aridity. Elevation has modified its transitional character so that, first, there is a geographic contribution to the lowland especially to the north, and, secondly, there are certain distinctive geographic relationships developed within the area. Finally, the area has been a refuge where the diversity of landforms has become reflected in the political and social structure of the people.

BELLO HORIZONTE AND OURO PRETO

A COMPARATIVE STUDY OF TWO BRAZILIAN CITIES

PRESTON E. JAMES

BELLO HORIZONTE and Ouro Preto are representative of two distinct phases of Brazilian settlement. Ouro Preto is old; its buildings, its narrow, irregular, cobble-paved streets, its layout, and the less tangible "atmosphere" of the place which these material forms combine to create, are all relics of the eighteenth century. Ouro Preto had its origin as a gold-mining camp, one of the richest of the state of Minas Geraes, at a time when Brazilian wealth was flowing largely from the gold and diamond mines north of Rio de Janeiro. But gold and diamonds have declined in importance in Brazilian economic life, and with this decline the mining communities have crumbled after the manner of mining communities the world over. The difficult accessibility of Ouro Preto, the cramped site it occupied, together with other considerations, led in 1896 to the removal of the political center of Minas Geraes to another location. Bello Horizonte is a new city; unencumbered by history or tradition, since about every man-made feature of this urban center is less than forty years old, this city belongs to the future. It is a response, however misguided, to an ideal.

Both Bello Horizonte and Ouro Preto are located in the economic hinterland of Rio de Janeiro. They are both most easily reached from this port (Map 19). Both lie close to the center of the great interior state of Minas Geraes, the most populous of all the states in the Brazilian federation. In climatic situation they occupy a plateau near the margin of the low lati-

MAP 19. General map of a part of southeastern Brazil, showing location of cities mentioned in relation to mountains

tudes at such elevations that the tropical heat is modified, but without the weather variations characteristic of the middle latitudes (Cw).[1]

[1] Bello Horizonte is Cwa: its coldest month (July) is 16.8°C (62.2°F), its warmest month (February) is 22.3°C (72.1°F); its total annual rainfall is 1,500 mm. (59 in.), coming chiefly from October to March. Ouro Preto is Cwb: its coldest month (July) is 13.9°C (57.0°F), its warmest month (February) is 19.6°C (67.3°F); its total annual rainfall is 2,136.3 mm. (84 in.), coming chiefly in summer. Figures from *Boletim de Normaes de Temperatura, Chuva, e Insolacão, correspondentes aos annos de 1914 a 1921*, Estado de Minas Geraes, Commissão Geographica e Geologica, Secção Central do Serviço Meteorologico, Bello Horizonte, 1923.

Ouro Preto

The earliest settlements in Minas Geraes were mining towns which were established soon after the discovery of gold in 1694.[2] Bands of restless Paulistas, whose efforts resulted in the exploration and settlement of much of the interior of Middle Brazil, soon located colonies in the neighborhood of the richest ores or placer deposits. One of these Paulistas established the first settlement on the site of Ouro Preto in 1698.[3] All these settlements, notably Villa Rica (Ouro Preto), Sabara, Tejuco (Diamantina), and São João d'el-Rey, are of the same general character. In common with all purely mining towns they show a disregard for those qualities of site and situation which are so important in the location of commercial towns. The mine is the *functional nucleus* of such towns; a focal location with easy accessibility to the surrounding territory, or even a favorable terrain on which to place the streets and buildings, is a matter of minor importance. The most favorable terrain close by the functional nucleus is chosen for the site; and access to the town is gained by the best available route, however difficult it may be.

THE TERRAIN

Ouro Preto lies on the lower mountain slopes of the northern side of the valley of the Ribeirão do Funil. To the north the Serra de Ouro Preto raises an even crest to somewhat over 1,550 meters above sea level; to the south lies another mountain range, culminating in the curiously shaped Pico de Itacolomi. Between these two mountain ranges extends a broad, mature valley, with its graceful curves sweeping down to a bottom elevation of between 1,100 and 1,150 meters. Into the bottom of this mature valley recent rejuvenation has caused the Ribeirão do Funil to sink a narrow, youthful gorge, in places with vertical walls.[4] The

[2] Delgado de Carvalho, C., *Geographia do Brasil* (Rio de Janeiro, 1929), p. 333.

[3] Ouro Preto has been known under several names: São João Baptista de Ouro Preto, from 1698 to 1711; Villa Rica de Albuquerque, from 1711 to 1720; Villa Rica de Ouro Preto, from 1720 to 1823; and Imperial Cidade de Ouro Preto, from 1823 to the present day. Vasconcellos, M., *Vias Brasileiras de Communicacão*, 2a. Edicão (Rio de Janeiro, 1928), p. 326.

[4] The Portuguese word *Funil* means "funnel."

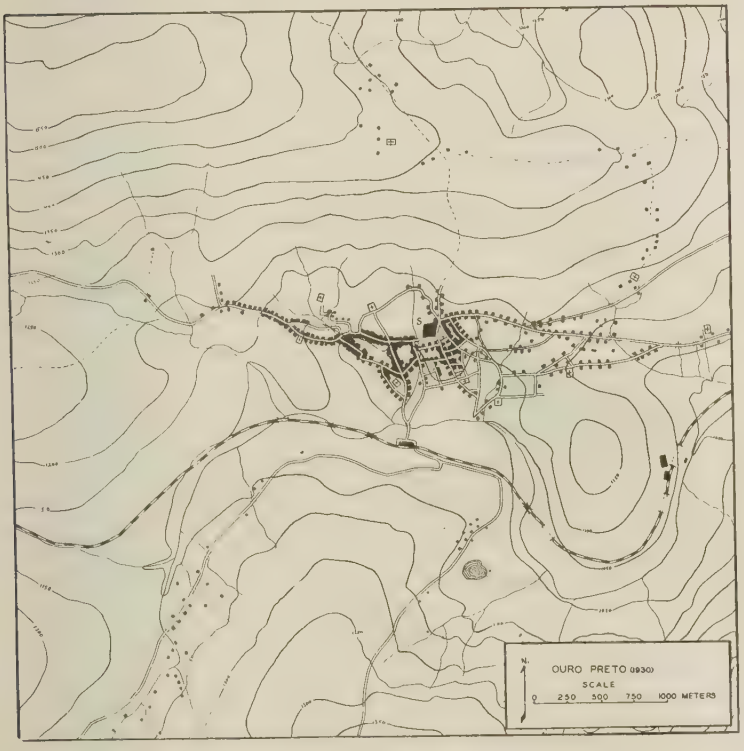
tributaries to this stream have fretted the floor of the earlier broad valley. In their lower courses, near their junction with the main stream, they have cut gorges nearly as narrow and steep-sided as the gorge through which the Riberião do Funil makes its turbulent way; but upstream, toward the base of the mountains, the tributary valleys broaden to an amphitheatral shape. Near the mountain base they have been widened until only narrow ridges, now slightly below the level of the earlier valley floor, separate their drainage basins. The chief remnants of the earlier surface are the flat-topped hills which overlook the main gorge and which mark the less dissected downstream ends of the insequent divides. Ouro Preto is strung out along the mountain base, running across three of the amphitheatral valley heads and festooned over the narrow divides which separate them (Pl. XVIII, Figs. 1–2).

THE URBAN MORPHOLOGY

Irregularity of street pattern is a characteristic feature of the Brazilian colonial culture. In fact, one may look at Lisbon with its irregularly arranged core for the prototype of the Portuguese colonial settlements throughout Brazil. In other words, the apparently haphazard arrangement of Ouro Preto (Map 20) is not imposed solely by the hilly nature of its site, but the flexibility which permits intimate adjustment to the qualities of the terrain was inherent in the culture of its period of origin.

The essential feature of the origin of a pattern such as came to be developed at Ouro Preto is the lack of any major plan. Each street was established much as paths are worn on vacant lots, following the easiest route from one place to another, turning aside to avoid even minor and temporary obstacles. Once established, houses were built along it, and what had been the result of a more or less unconscious choice on the part of a small group of people became crystallized as a part of the pattern of the urban landscape. In general, the roads of Ouro Preto follow the contour of the surface, in the steeper places forming a series of terraces one above the other, with short ascents or descents from one level to another by the most expedient routes. When, in 1888, the railroad from the west reached Ouro Preto, the line followed the valley

bottom, avoiding only the deepest parts of the inner gorge. The station was placed where a road already descended from the city to cross the valley to some scattered mining communities on the



Map 20. Ouro Preto

southern side. Little extension of the city toward the railroad station has taken place.

The houses of Ouro Preto stand very close together or actually touching. Each street is practically shut in by the houses or walls which rise directly from the narrow sidewalk. One gains the impression of crowding, even near the limits of the town, where the

houses string out along a single street after the manner of a typical *Strassendorf*, and where there is no view of the gardens and open fields lying so close at hand. From the air, or from a neighboring elevation, however, one gets quite the opposite impression. Even the insides of the blocks contain trees and gardens, and the urban forms are seen to exist only as an outline or skeleton. The houses themselves are one or two stories in height, mostly of white-washed adobe plastered on a framework of either wattle, as in the newer ones, or brick, as in the older ones. The red-tile roof is characteristic. The architectural types, especially near the center of the town, show many fine examples of the mode of the colonial period (see Pls. XVIII–XX).

Undoubtedly the most striking feature of this urban landscape at the present time is the large number of churches. Scattered throughout the town are about twenty-one imposing structures, some of which contain magnificent carvings and paintings. Almost any view of Ouro Preto is dominated by one or more of these buildings, not only because they stand high above the one- or two-story dwellings in their vicinity, but also because they are commonly located on such commanding eminences of the terrain as the ridges between the amphitheatral valleys (Pl. XVIII, Fig. 1; Pl. XIX, Fig. 1). This close juxtaposition of the artistic and the crude is quite characteristic of frontier settlements, but it is all the more striking in Ouro Preto because the usual development of the frontier town was arrested with the decline of the mines and the removal of the political function. Most of the churches stand idle, with their art treasures in serious danger of damage or loss.

There is little differentiation of functional areas in Ouro Preto at the present time. The mines, for which the settlement originally was established, are now abandoned; their openings, partly caved in, are still visible along the mountain side in the upper part of the town (Pl. XIX, Fig. 2). The old government buildings, now utilized by the School of Mines, occupy a central position (shown by the letter *S* on Map 20). If there is any commercial center (Pl. XX, Fig. 1) it is located in the area south and west of the School of Mines; but there is actually little to differentiate this

section from any other section, except that there are fewer vacant plats and fewer of the buildings are standing unoccupied. It is in this part of the town that the much-reduced present-day population has established itself, leaving the outlying parts to fall into obvious decadence.[5]

THE RELATION OF OURO PRETO TO THE LARGER REGION

The structure of Ouro Preto as regards its functional areas cannot be interpreted, however, without reference to the relation of this urban center to the larger region, the surrounding parts of southeastern Minas Geraes. As we have pointed out, the town owes its location to the presence of gold ores. Being one of the richest of the mining communities, it became the political center of the state early in the nineteenth century,[6] but this additional function was due to the wealth and power already congregated around the mines at Ouro Preto. During the nineteenth century there were as many as 35,000 or 40,000 people in Ouro Preto.[7]

During all this time, however, Ouro Preto remained dominantly a mining community, and the mining economy ruled the politics of the state. It is a characteristic inherent in mining communities to be located at the end of the road, rather than at a focus of roads. Roads perhaps are extended to such mining settlements from several directions, but the greater part of the traffic over the roads originates at the mine and moves away from it. Thus during the eighteenth and nineteenth centuries roads reached Villa Rica from Rio de Janeiro, from São Paulo, from the east coast by way of the Rio Doce, and from distant Bahia by way of the São Francisco Valley.[8] But Ouro Preto was the inner

[5] Saint-Hilaire, Auguste de, *Voyage dans les provinces de Rio de Janeiro et de Minas Geraes* (Paris, 1830), p. 138. The following account was written in 1816:

"On compte, à Villa Rica, environ deux mille maisons. Cette ville était florissante, lorsque les terrains qui l'environnent fournissaient de l'or en abondance; mais à mesure que ce metal est devenu plus rare ou plus difficile à extraire, les habitants ont été peu à peu chercher fortune ailleurs, et, dans quelques rues, les maisons sont presque abandonnées."

[6] Jacob, R., *Minas Geraes no XX° Seculo* (Rio de Janeiro, 1911). See especially the table on page 141.

[7] See Dos Santos, L. J., *Historia de Minas Geraes* (São Paulo, 1926).

[8] Delgado de Carvalho, *op. cit.*, p. 334.

end of these roads rather than the focus of them. It does not occupy a position which is in any way a natural focal point of routes of travel. For this reason it was always handicapped in the performance, for the larger region, of political, commercial, or manufactural functions.

In 1896 the capital of the state of Minas Geraes was transferred officially to the new city of Bello Horizonte. With it went any attempt on the part of Ouro Preto to perform the commercial functions for the larger region. The change was stimulated, then, not only by the cramped nature of the site of Ouro Preto, but also by its unfavorable situation with respect to routes of travel.[9] In 1896 Ouro Preto had approximately 30,000 inhabitants; at the present day it has about 6,000. It still has its School of Mines; it is a potential center for art; but its other functions have been taken away, and there remains only the empty shell — the relict pattern stamped on the face of the earth by the activities of other days, now rapidly falling into decadence.

Bello Horizonte

In the most complete contrast to Ouro Preto stands Bello Horizonte. The contrast is not only one of site and functions, but also one of pattern, aspect, and that immaterial quality of atmosphere or personality which is so easy to appreciate but so difficult to portray. Bello Horizonte is the expression of the modern era. Whereas in other cities which have continued their growth into modern times the new features and patterns have been developed as additions to the older parts, or as modifications of preëxisting patterns, Bello Horizonte is completely new, with the exception, as we shall see, of one minor connection with the earlier occupance on this site. Bello Horizonte is facing the vision of its future; Ouro Preto recalls the memories of its past.

THE TERRAIN

When the *mineiros* decided to establish a new capital they looked for a site which would give plenty of room for growth. But

[9] Haushofer, A., "Ouro Preto und Bello Horizonte: Eine städtegeographische Studie," *Mitt. der Geog. Gesell. in München*, 18 (1925) : 293–311.

anything approaching level land in Minas Geraes is difficult to find. This part of southeastern Brazil is made up of crystalline plateaus lying some 800 to 1,000 meters above sea level. The plateaus are surmounted by such mountains as those around Ouro Preto (Map 19), and are dissected by streams which without exception show the usual indications of recent rejuvenation.[10] Level surfaces, then, are to be found only in a very few, isolated bits of valley flat along the deeply incised river valleys, or on the youthful interfluves which the tributary streams have not yet dissected.

The site chosen for the city of Bello Horizonte is of the latter type. It lies just north of the Serra do Curral, a part of the Serra do Espinhaço of central Minas Geraes, and a little west of the deep, youthful valley of the Rio das Velhas where it emerges from the

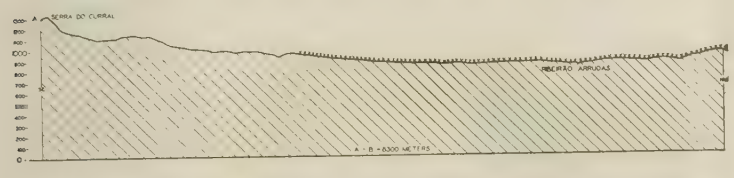
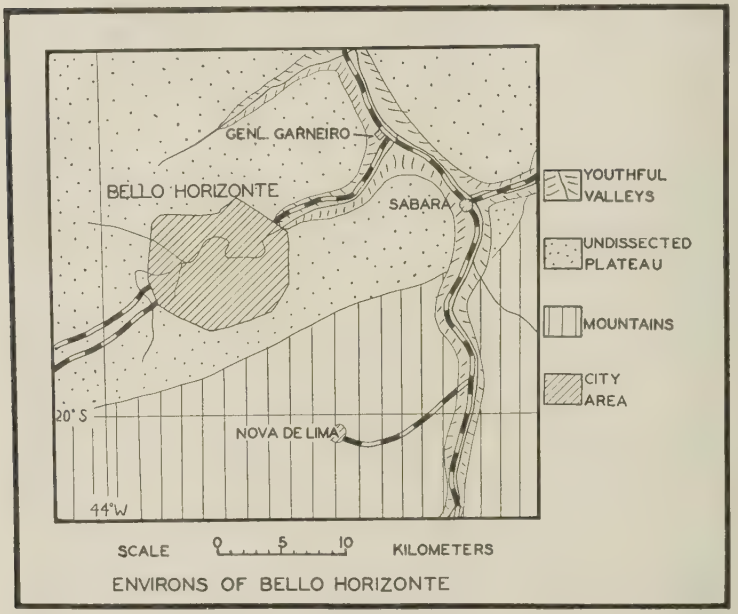


FIG. 6. Profile of the site of Bello Horizonte. (For location of the profile see line *A* — *B* on Map 22; *A* lies south of the border.)

mountains on its way toward the Rio São Francisco. In this region a plateau level at about 1,000 meters in elevation is extensively preserved, with broad, open valleys cut below the higher level to another at about 800 meters. The main streams, like the Rio das Velhas, flow through narrow, youthful canyons with intrenched meanders incised in the valleys of the 800-meter level, and tributaries of the main streams are extending their V-notch valleys headward into the plateaus. About 8 kilometers downstream from Sabara, the Rio das Velhas is joined by a left-bank tributary, the Ribeirão Arrudas, at an elevation just under 700 meters. This stream has extended its youthful gorge some 14 kilometers into the upland west of the Rio das Velhas; but beyond this it flows through a valley only slightly below the general

[10] Delgado de Carvalho, C., *Physiographia do Brasil* (Rio de Janeiro, no date).

800-meter level, having the characteristic open V-profile of youthful headwater streams. Just above the gorge of the Ribeirão Arrudas, in a broad, open, basin-like valley which curves down from the 1,000-meter remnants on either side to the 800-meter



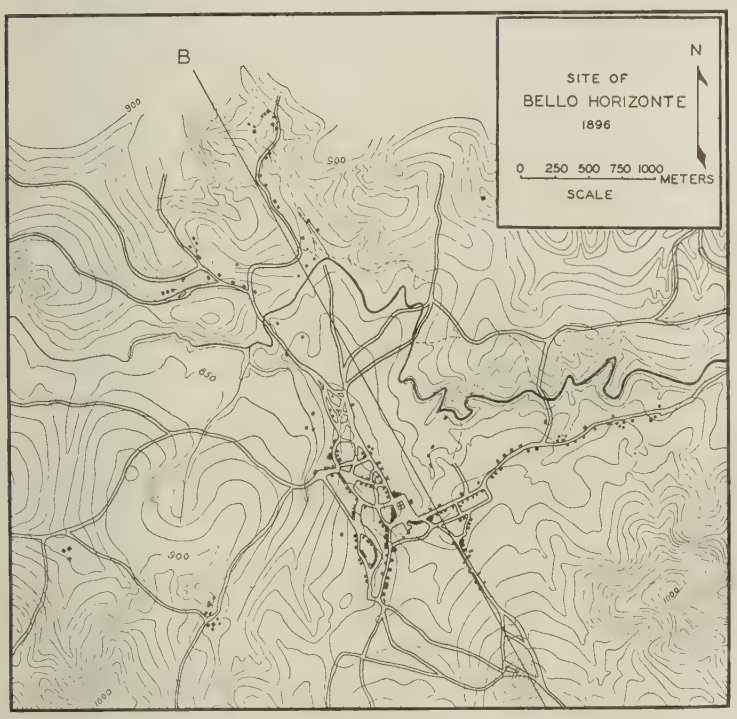
Map 21. Environs of Bello Horizonte

level in the middle, is the site of Bello Horizonte (Pl. XXI, Fig. 1, text Fig. 6, Map 21).

THE URBAN MORPHOLOGY

This site was occupied before 1890 by the small rural village of Curral d'el-Rey (Map 22). Although the village was not a mining settlement, its pattern, like that of Ouro Preto, was characteristic of the colonial culture. Its irregularity was in no way related to a rough terrain. Curral d'el-Rey owed its location to the convergence of three locally significant roads, in this respect differing

from the mining type of settlement illustrated by Ouro Preto. One road led down the gorge of the Ribeirão Arrudas and up the valley of the Rio das Velhas to Sabara; the second, into the Serra do Curral to the south; and a third into the wilderness, or *sertão*, toward the north. At the junction of these three roads was



Map 22. Curral d'el-Rey, the site of Bello Horizonte in 1896

an open *praça*, or plaza, in the center of which was a church. This was the historical nucleus of the settlement, its "point of attachment" to the earth. Around it the characteristic unplanned street pattern, with the strings of houses, had developed — all the more irregular because of the gentle slopes of the terrain.

The development of a city of 100,000 people on this site might

have been made with Curral d'el-Rey as a base. This would have been the usual course of events. Even Rio de Janeiro and São Paulo carry in their centers the narrow, irregular street pattern of such an unplanned beginning. But when the new capital was projected, it was determined to wipe out the existing settlement and begin again. The remarkable thing to record is that this apparently was accomplished without the graft and political corruption so frequently exhibited under similar conditions elsewhere.[11] Only one remnant of Curral d'el-Rey was suffered to remain: the church which marked its center. It alone served as the point around which was oriented the otherwise entirely new pattern of Bello Horizonte.

During the closing years of the nineteenth century the acme of perfection in city plans was supposed to be Major L'Enfant's layout of Washington, D. C. Accordingly, a rectangular system was used as a base, then another, but more widely spaced, system of avenues was superimposed on the first and oriented at an angle of 45° to it. Around the periphery of the city a broad boulevard was laid out (Map 23). With the specter of too narrow roadways before them, the town planners made the basic system of streets twenty meters wide, and the avenues thirty-five meters — widths which have imposed on the city a heavy financial burden [12] in paving costs (Pl. XX, Fig. 2). This pattern of streets was oriented conveniently on the terrain with the old church of Curral d'el-Rey as a pivot. The location of this church in present-day Bello Horizonte is marked by a black star on Map 23.

In 1930 the original layout of the city had still not been entirely built up. A considerable section in the southwest was composed only of grassy fields crossed by the traces of the roadways (Pl. XXII, Fig. 2). Beyond the limits of the original city, however, an extensive zone of suburban subdivisions had been platted and partly developed. These subdivisions have somewhat irregularly rectangular plans, variously articulated with the main city.

[11] Verdussen, J., "Bello Horizonte, nouvelle capitale de l'état de Minas Geraes," *Rev. de l'Am. Latine*, 18 (1929) : 434–438.

[12] Machado, C. M., *Mensagem apresentada pelo Prefeito . . . ao Conselho Deliberativo de Bello Horizonte, em 10 de Outubro de 1929, e relatorios annexos* (Bello Horizonte, 1929). See especially pp. 71–79.

LEGEND
COMMERCIAL CORE
LOCAL RETAIL, SMALL WORKSHOP
RAILROADS
INDUSTRIES
SUPERIOR RESIDENCE
ORDINARY RESIDENCE
POOR RESIDENCE
SUBURBAN RESIDENCE
PUBLIC BUILDINGS
GOVERNMENT BUILDINGS
PARKS AND CEMETERIES
VACANT
BELLO HORIZONTE
FUNCTIONAL AREAS
1930
SCALE
0 250 500 750 1000
METERS

MAP 23

Before turning to a discussion of the pattern of functional areas the relation of this city to the larger region must be considered.

THE RELATION OF BELLO HORIZONTE TO THE LARGER REGION

The urban functions which center on Bello Horizonte are chiefly political and commercial. As state capital this new city became immediately an important focus, but for various reasons it has not yet achieved a preëminent position in the commerce of the state. In other words, the territory which it serves in the function of political center is much more extensive than that for which it serves as commercial center or as collecting point for the shipment of local products to the coast. The territory reached by its manufactures is still more narrowly limited.

The reason for this is, in part, the location which was chosen for it. In addition to the selection of a site sufficiently level to accommodate a large city, a point was desired somewhere near the center of the state of Minas Geraes. Bello Horizonte lies very close to the center of this political unit. But Minas Geraes is a very large state, and one which contains within its borders a very great variety of conditions. The population is concentrated in the southern and eastern parts of the state, whereas to the north and west lie the vast expanses of plateau grasslands (with Aw climate), in part utilized for great cattle ranges and with only scattered and isolated pioneer settlements, and in part quite uninhabited except by Indians. Thus Bello Horizonte is not actually in the middle of the settled portion of Minas Geraes, but is located almost on the pioneer fringe. Furthermore, its position on the north and west of the Serra do Espinhaço, which forms a distinct barrier to movement, shuts it out from easy communication with the most populous districts of the state which lie to the south and east of this range (Map 19).

Railroads, to be sure, now reach Bello Horizonte from various directions. The main line to the south does not follow the more direct route through the Serra do Espinhaço, but bends around its western edge. From Sabara in the valley of the Rio das Velhas, a line extends northward to the isolated outpost of Pirapora on the

São Francisco, and another crosses the mountains eastward to Santa Barbara. From Bello Horizonte itself another railroad runs westward into the western part of the state. The capital city has become a railroad focus of a sort, but the focus is a highly artificial one. Bello Horizonte represents no more of a regional focus of natural lines of travel than does Ouro Preto, especially when we recall that the territory to the north is virtually unsettled. Barbacena is much more of a natural focus of routes, since both ridges and valleys radiate from this high point on the plateau and since it is easily accessible to the most populous districts. Juiz de Fora, as the southern outlet of the state, might have become the collecting point for shipments from a wide area of the interior. Instead, however, the lines of travel have radiated from the port of Rio de Janeiro, and no all-embracing focus of routes has developed in southern Minas Geraes. With the opening of the railroad outlet by way of the Rio Doce, another and widely divergent outlet will be provided, still further scattering the commercial orientation of the state.

Bello Horizonte, then, will increase its commercial importance only as the territory to the north is settled. In this respect it is a city of the future, built in response to a vision. But for the present the fulfillment of its vision is incomplete.

INCREASE OF POPULATION IN BELLO HORIZONTE [13]

1900	13,472
1905	17,191
1910	32,300
1915	45,741
1920	52,619
1925	85,224
1930	120,000 (estimated)

The enormous increase in population, as shown by the table, is partly the result of the depopulation of smaller places elsewhere in the state. Though these shifts in population within Brazil

[13] Figures from *Algumas Notas sobre o Estado de Minas Geraes*, Bello Horizonte, 1930. Estado do Minas Geraes, Serviço de Estatistica Geral. (*In manuscript.*)

have not been adequately studied, their reality is recognized. Bowman describes, for instance, the withdrawal of the frontier of settlement in the north as a result of the construction of railroads farther south.[14] No doubt a part of this decline visible on the frontier accounts for the numbers of people who have moved into the suburban zones of Bello Horizonte and exist there with no very lucrative source of employment.

FUNCTIONAL AREAS

These functional relationships of Bello Horizonte to the larger region are reflected in the present pattern or arrangement of the areas within the city which are devoted to the various urban functions.[15] Unlike Ouro Preto there is a distinct differentiation of Bello Horizonte into such areas (Map 23). The political function centers on the governor's palace, located in the midst of a park at the intersection of two of the wider avenues near the southern end of the built-up part of the city. This site was chosen, no doubt, to take advantage of the high ground of a spur somewhat below the 1,000-meter level. Several other government buildings are located near the palace, but still others are scattered throughout the city, some even in the suburban fringe.

The commercial function centers in the "commercial core" — the commercial and business area which serves the larger region beyond the immediate urban limits, as opposed to the local retail stores, which are differentiated from the commercial core. In arrangement this core is distinctly attenuated, extending along the sides of one of the broad southeast-northwest avenues, and at right angles to this along another avenue, which leads down to the railroad station. These avenues extend conveniently across the gentle lower slopes of a spur on the inside of a bend of the Ribeirão Arrudas. Much of the remainder of the area inside this bend is taken up with a characteristic Brazilian complex of small retail stores and workshops, and with manufacturing establishments in-

[14] Bowman, I., "The Pioneer Fringe," *Am. Geog. Soc.*, Special Publication, No. 13 (New York, 1931): 301.

[15] A workable classification of urban "functions" is given on page 572 of a paper by Aurousseau, M., "The Distribution of Population, A Constructive Problem," *Geog. Rev.*, 11 (1921): 563–592.

terspersed with poor residences. The railroad lines and the associated warehouses and shops follow the lower part of the valley.

The manufacturing units of Bello Horizonte are various, but mostly of only local significance. On Map 23 only those industrial establishments which occupy their own buildings, or at least the greater part of a building, are classed as industries. The small workshop and local retail area includes a number of small units occupying restricted quarters and, in many cases, carrying on the retail sale of their products along the street front. The nature of the manufacturing in this city is indicated by the following table for 1927,[16] which includes all establishments, whatever may be their size.

NUMBER OF MANUFACTURING ESTABLISHMENTS IN BELLO HORIZONTE

Woodworking shops, including furniture	14
Printing shops	13
Pharmaceutical supplies	10
Alcoholic beverages	10
Marble cutters	7
Shoes	7
Coffee mills	6
Textiles	5
Confections	5
Macaroni	5
Soap	5
Machine shops	5
Miscellaneous	37
TOTAL	129

A better idea of the relative importance of these industries, however, is gained from the following table, which shows the percentage of the electric power used for different classes of industry in Bello Horizonte during the first six months of 1930.[17]

[16] Table from statistics in *Indicador agro-pecuario, industrial, commercial, e bancario de Minas Geraes*, Anno I, 1927, Estado de Minas Geraes, Serviço de Estatistica Geral, Bello Horizonte, 1928.

[17] Information from the local power company.

PERCENTAGE OF TOTAL ELECTRIC POWER USED IN INDUSTRIES

	Percentage
Woodworking shops	19
Textiles	11
Metal works	10
Food manufactures	7
Quarries	7
Transportation	5
Miscellaneous	41

This list of industries is a typical one for the cities of the Brazilian plateau. High protective tariffs permit the existence of many small establishments, especially textile, throughout the interior. Even Ouro Preto has its textile mill. However, the local nature of these manufacturing activities is attested not only by the small scale on which they operate, but also by their independence of rail connections. The manufacturing areas of these cities are not tied to the railroads, as in similar cities of North America. Although many of the industries of Bello Horizonte are in the valley of the Ribeirão Arrudas, by no means are all of them so located. And for most of those which are in the valley cheap land and not proximity to the railroads is the cause.

The residence districts of Bello Horizonte are divided into four classes: poor, ordinary, superior, and suburban. Of these classes, superior and poor are quite distinct and easy to recognize. The houses of the superior residence district are more elaborate and expensive, and occupy relatively larger lots, with a street frontage of generally over twenty meters. The poor residence districts, on the other hand, are composed of small houses of cheap construction, on small lots. Only the main thoroughfares of these districts are paved, and the red clay of the underlying soil tinges the sidewalks, the walls of the buildings, and even the inhabitants, both animal and human, with an orange hue. Between these two extremes, the ordinary residence district represents somewhat greater variation of type (Pl. XXI, Fig. 2). Where less than fifty per cent of each block has been built up, or otherwise developed, a fourth residence district is recognized. In character the sub-

urban zone most closely resembles the poor residence district. Its streets are with few exceptions unpaved, and such public services as water or light are rare (Pl. XXII, Figs. 1–2).

The distribution pattern of these residence districts is not unusual. The superior district is concentrated on the higher part of the spur close by the governor's palace and the neighboring group of government buildings. Ordinary residences fill in most of the rest of the original layout not taken up by commerce or industry. The poor residence districts are mostly along the lower sections of the valley and on the northern slopes. Suburban residences form an almost complete ring around the outskirts of the city.

A quantitative analysis of functional areas of this city is of interest, especially when compared with one of a North American city. In the following table the percentage of the total area devoted to the various uses we have just described is compared with a similar analysis of Vicksburg, Mississippi.[18] In both studies the total areas in reference to which the percentages are measured are the inner parts, in which at least 50 per cent of each block has been built up or otherwise developed for urban use. In order to make such quantitative analyses strictly comparable, this definition of the geographic urban area has been adopted. The reason for the exclusion of the suburban zone, where less than 50 per cent of each block is built up (or developed as parks, etc.), is that in many cities the outer limits of this zone are very difficult to establish with precision, whereas the limits of the more continuously built up or developed area can be precisely recognized. It should be noted that Vicksburg is a much smaller city, having a population in 1930 of about 23,000, as compared with 120,000 for Bello Horizonte. The smaller percentages of area devoted to commercial core and industry in the case of Bello Horizonte reflect the relatively small extent to which this city performs these functions for the larger region.

[18] James, P. E., "Vicksburg, A Study in Urban Geography," *Geog. Rev.*, 21 (1931) : 234–243. Reference on page 241.

QUANTITATIVE ANALYSES OF BELLO HORIZONTE AND VICKSBURG (MISSISSIPPI)

Bello Horizonte	Percentage	Vicksburg	Percentage
Commercial core	1	Commercial core	3
Small retail and workshop	7	Wholesale	2
Railroad	3		
Industries	2	Industries	7
Superior residence	3	Superior residence	7
Ordinary residence	27	Ordinary residence	30
Poor residence	28	Poor residence	41
Public buildings	5		
Government buildings	3		
Parks, etc.	8	Parks, etc.	1
Vacant land within the urban limits	13	Vacant land within the urban limits	9

Conclusion

Bello Horizonte and Ouro Preto represent two extremes among Brazilian cities. They also illustrate two common problems which cities in their development have to face. The first problem arises when the growth of an urban center brings to it functions and activities for which no adequate plan had previously been devised. The unplanned irregularity of the colonial cities, even of the major ones, is an indication that their inhabitants were essentially rural-minded. Most cities cannot be transplanted, and so must do the best they can to perform the functions of a city within the framework of a rural village. In Minas Geraes, however, a number of factors led to the creation of a new city, unencumbered by an inadequate inheritance. Ouro Preto, as a mining settlement, was located without reference to those qualities of site and situation which are usually called upon to explain urban growth. With rugged terrain, without the advantages of even a local, natural convergence of routes, Ouro Preto could not easily adjust itself to carry on the additional political and commercial functions for the larger region.

A people less imaginative than the Brazilians might have struggled to find a local solution to this difficulty. With the examples of Washington, Canberra, and La Plata before them,

the *mineiros* set out to build for themselves an ideal city. Bello Horizonte is an entirely modern city, built by an idealistic and capable people. Yet it, also, is not without its problems. The difficulty of forecasting the future of a city is inherent in all city planning. To plan for one destiny may be to provide inadequately for a lesser one. Bello Horizonte, near the center of the state of Minas Geraes, looks to a future when it may truly become the focus of a widespread population — when the northwest as well as the southeast shall have been won from the wilderness. For the present, some other location might have been more satisfactory, such as Barbacena or Juiz de Fora. The spread of population into the north will involve many problems regarding the suitability of these lands for human settlement; and even if they prove hospitable, it is not at all unreasonable to predict that the cooler plateau of the south, with its dependable rainfall, will remain the center of population. Bello Horizonte, however, is placed to serve the northern frontier. Its future is bound up with the advance of settlement into these new lands; it is planning and preparing for a destiny which cannot yet with confidence be predicted.

University of Michigan

FIG. 1. Ouro Preto, looking east from the northeast corner of the school of Mines (see Map 20). In the middle ground is one of the amphitheatral valleys; in the background a narrow ridge surmounted by one of the cathedrals. The mountains rise abruptly on the left

FIG. 2. *Strassendorf* development on the outskirts of Ouro Preto

Fig. 1. The "Casa de Contos," or mint of colonial Ouro Preto — a typical example of colonial architecture

Fig. 2. Abandoned mine openings in Ouro Preto

FIG. 1. The main street in the heart of Ouro Preto. On the mountain slope in the background an abandoned residence of the mining period

FIG. 2. The main street of the commercial core in Bello Horizonte

FIG. 1. Bello Horizonte: Avenida Affonso Penna, through which the line A–B passes (Map 22), taken from the southeastern limit of the original city. The 1,000-meter level forms the sky line, with the 800-meter level in the middle distance. The group of government buildings around the governor's palace is visible in the middle distance on the left

FIG. 2. A typical house in the ordinary residence district of Bello Horizonte. Note the mural painting on the veranda

FIG. 1. Types of houses of the poorer part of the suburban residence district. Photograph taken at the southeastern end of the Avenida Affonso Penna, looking in the opposite direction from that in Plate XXI, Fig. 1.

FIG. 2. The section of the original city not yet built up. Photograph taken from the edge of the superior residence district near the governor's palace, looking west

OBJECTIVES AND METHODS IN THE LAKE INVENTORY IN MICHIGAN

K. C. McMURRY, R. W. ESCHMEYER, AND C. M. DAVIS

THE problem of maintaining supplies of game and fish for a constantly increasing body of consumers has been attacked from various angles. The first step was restriction by legislative action, lowering of bag limits, and shortening of seasons, with a corresponding development of enforcement machinery. As this gradually proved inadequate, the idea of artificial propagation came in; pheasants were reared and released, fish hatcheries were established, and plantings were made by a broadcast system. The bulk of the work of most conservation departments still centers about these two ideas, and most of the arguments which are prevalent among sportsmen and sportsmen's organizations are based upon the details therein embodied.

The idea of game management through control of the environment has gained much headway in recent years and is nowhere more evident than in Michigan. Among the outstanding examples is the work of the Institute for Fisheries Research with its Lake Survey.

The theory involved is simple. Scientific study of the habits and habitats of the different species develops a knowledge of the essential requirements of environment under which they may survive and multiply. Modification of the actual environment by various artificial means may better conditions for a given species or association, and an approach to optimum conditions for highest productivity may be effected. Such management may prove to be more successful in preserving or increasing the supply of wild-life forms than any conceivable extension of restrictive regulations or artificial propagation, and the basis may be laid for a more effective and reasonable application of both of these latter policies.

The general application of the term "management" falls under two rather distinct heads. These are:

(1) Scientific investigation of the habits and requirements of species and associations of species. This is the work, primarily, of the highly specialized zoölogist. Much progress has been made in the direction of a complete knowledge, but an almost endless series of further investigations is in view, for in many connections very little is definitely known. Investigations of quail, pheasants, Hungarian partridge, and various fishes indicate the type of study required and in progress. Doubtless all important species will ultimately be studied in detail. Enough is now known, especially for the more important species of fish, to make practical applications in projects of management.

(2) The environmental data, together with the various additional data relating to the present distribution, kinds, and quantities of wild-life forms, must be analyzed and interpreted in the light of zoölogical knowledge of the habitats and the adaptabilities of the forms involved. On this basis recommendations may be made: whether or not the given situation warrants management; which species should be cultivated; what modifications and improvements should be introduced; what propagations and plantings should be made; and what restrictions would be in order. Possibly a third step is involved in the actual administration of areas. In the Lake Survey each of these essential items in a complete management plan has been included, and the results mark very significant progress in the application of the idea.

Geographers have naturally been interested and involved in the inventory idea from its inception. Analysis of the factors of the environment, the completed picture of the environment, life distributions, and life relationships to the environment always have been basic geographic materials and interests. At the start the inventory led to the preparation of maps and more and more such data have been produced in map form. In all the game-management programs maps have played an important part. It is natural, therefore, that coöperative arrangements should be made between zoölogists and geographers in the furtherance of

various projects. In the case of the Lake Survey especially the plan has worked to the benefit of both. In actual practice the demarcation between the techniques is not sharp; the work of the inventory falls to him who at the moment is able and ready to do the particular job necessary.

That the Institute for Fisheries Research answers a public demand is evident from the bodies which support its work. The Izaak Walton League in Michigan, through the generosity of Mr. Harry M. Harper, maintains fellowships for those who carry out the work of the Institute. The Department of Conservation of the State of Michigan pays the working expenses. Dr. Carl L. Hubbs, of the University of Michigan Museum, is the director, and from him come most of the ideas, inspiration, and technical information which keep the Institute a valuable functioning reality.

The work of the Lake Division of the Institute falls into two distinct classes: first, the inventorying of lakes, and, second, the recommending of environmental changes, based on the inventories, which will increase the fish-carrying capacity of the lakes. The inventory is a field job which involves various geographical, biological, and chemical techniques. The recommendations are made from the laboratory and require a thorough knowledge of the natural habits of fishes.

The three sections of the inventory, geographical, biological, and chemical, include all the facts recorded about the lake selected for investigation. The geographical inventory determines its situation, size, shape, and connections; the nature of the land surface, cover, and human occupation along the shores; and the configuration and soil covering of the bottom of the lake. All these data are recorded on a map which serves as a working base in the field and forms a part of the final report. The biological inventory determines in great detail the nature and distribution of the plant and animal population of the lake. The physical inventory examines the temperature and chemical content of the water at various places and depths.

The geographical inventory centers upon the preparation of the map. Mapping a lake is a compromise between speed and accuracy. Since the map forms a base upon which the data of

the various inventories are recorded, it must be available as soon as possible. Further, it must show with considerable accuracy the small indentations of the shore, the position of the submerged shelf, the location of other shallows, and similar detailed features.

For the preparation of such a map, plane-table work with a telescopic alidade and stadia readings is the most satisfactory method (Pl. XXIII, Fig. 1). Base mapping does not lend itself well to irregular areas, and is somewhat complicated by marshy or swampy shores and soft bottoms in shallow waters. With a good instrument and a long-distance rod it is possible to read up to a distance of 2,500 feet with fair accuracy. The boat moves along shore in an outboard motor boat, coming in at intervals to make a reading. The shore is given several readings more with the complexity of the shore line, but is normally about 300 feet. The actual delineation of the shore line from the points thus established is accomplished by a second trip in the boat around the lake. The shore line is drawn in between the known points, and the under-water shelf is located (Pl. XXIII, Fig. 2). No satisfactory method of mapping the under-water shelf with great accuracy and rapidity has yet been developed. In the method used the boat travels slowly along the edge of the shelf and the distance from shore is estimated. This works well on small lakes, but is inaccurate where the shelf extends out several hundred feet. The natural and cultural features on the shore are mapped on this second trip. Islands and large boulders have previously been sighted from the set-up point, and if more than one set-up has been made these are intersected. On large lakes many set-ups have to be made; to preserve accuracy, they are all closed-traversed on some points which have been selected as controls. In this manner a fairly accurate map can be made at the rate of approximately one mile of shore line per hour.

The sounding of the depths of small lakes presents no difficulties. This is accomplished by running on straight courses between prominent shore features, and taking soundings with a hand line, at time intervals. On larger and deeper lakes the process is more complicated, and much depends upon the accuracy of the base mapping. The boat courses are laid out in such a

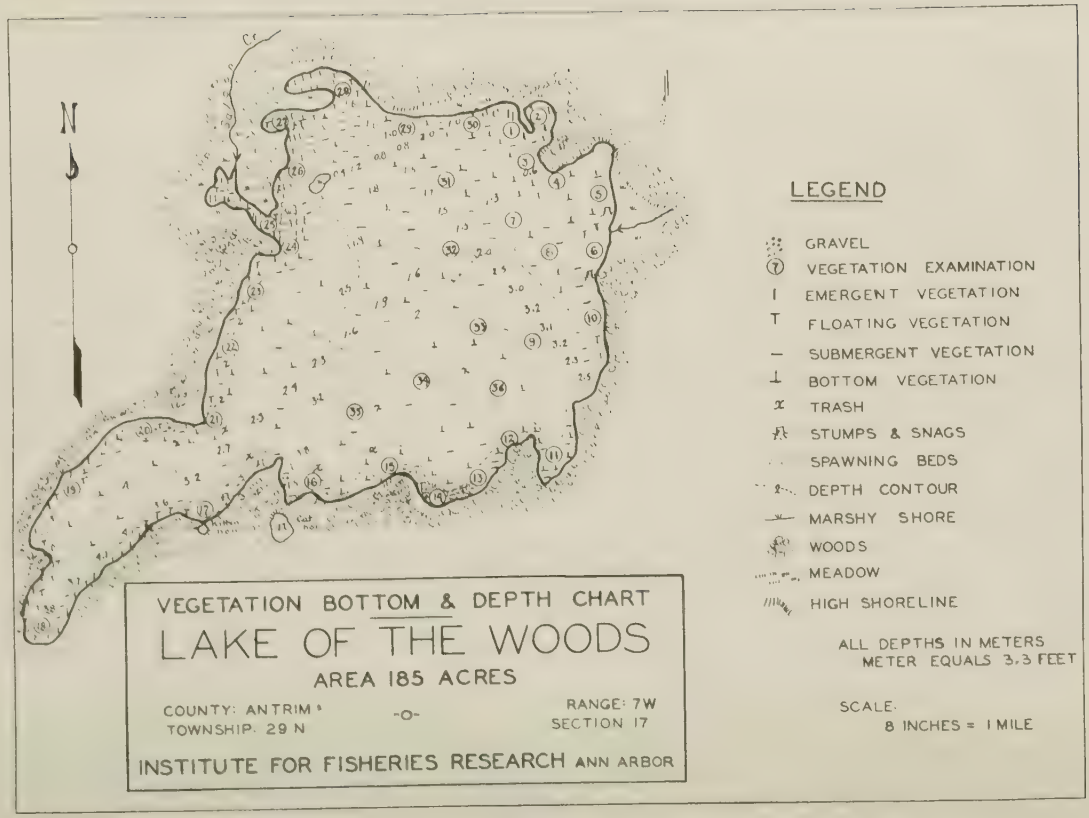
manner that they may be intersected with the alidade set-up on some known location. When a sounding is taken a signal flag is displayed, and the intersection is made between the line of sight on the boat and its course previously plotted on the map. If careful attention is given to details, this method is rapid and very accurate. The pilot must keep exactly on the course and must make allowances for wind and current drift. The surveyor must be sure of his position by compass direction and by check-sights on shore features. On long, narrow lakes, such as Torch and Elk, the courses were laid out on the section lines and their positions marked by large signal flags.

The bottom soils are examined by use of an Ekman dredge or a peat sampler (Pl. XXIV, Fig. 1).

The biological inventory, consisting of a botanical and a zoölogical analysis, is done with as much care and thoroughness as time permits. Data are recorded in general on the map (see Map 24, Lake of the Woods, Antrim Co.) and in much more detail on 6 × 9-inch cards. The aquatic and shore vegetation is examined at close intervals, and the species and density are determined and recorded. The inventory also includes examination and mapping of shelter, spawning areas, and general shallow-water conditions. Species of fish are determined and a general idea of their abundance is obtained (Pl. XXIV, Fig. 2). A study is made of the kind and the number of predators. Food sources are examined. Much more time is spent on the biological inventory than is used for both chemical and geographical investigation.

The physical inventory includes recording of temperatures of the water at many places on the lake and at all depths. Samples of water are drawn from various depths and analyzed for oxygen, carbon dioxide and alkalinity (Pl. XXIII, Fig. 3). Color is recorded after comparison with standard liquid color samples, and degree of transparency is obtained by depth-disc readings. All this information is recorded on a water-analysis summary card, to be considered in determining the kinds of fish with which the lake should be stocked.

An examination of the shore is made in as much detail as the particular lake seems to warrant. Pollution of the lake or its


N
LEGEND
GRAVEL
VEGETATION EXAMINATION
EMERGENT VEGETATION
FLOATING VEGETATION
SUBMERGENT VEGETATION
BOTTOM VEGETATION
TRASH
STUMPS & SNAGS
SPAWNING BEDS
DEPTH CONTOUR
MARSHY SHORE
WOODS
MEADOW
HIGH SHORELINE
ALL DEPTHS IN METERS
METER EQUALS 3.3 FEET
SCALE.
8 INCHES = 1 MILE
VEGETATION BOTTOM & DEPTH CHART
LAKE OF THE WOODS
AREA 185 ACRES
COUNTY: ANTRIM
TOWNSHIP: 29 N
-O-
RANGE: 7W
SECTION 17
INSTITUTE FOR FISHERIES RESEARCH ANN ARBOR

Map 24

connecting waters is recorded, and obstructions to passage of fish along shore or in inlets and outlets are examined at this time. A general history of fishing in the lake is obtained from residents, together with such miscellaneous information as comes to notice. Although local accounts are notoriously inaccurate, they are the only source of certain kinds of information.

When all the material is gathered, sorted, and checked in the field, it is submitted to the laboratory, where the far more important task of evaluating it is accomplished. After careful and complete consideration, a management plan for the individual lake is proposed. This includes recommendations for certain desirable changes in the environment and for stocking with species for which the lake is best adapted. The environmental changes are not radical. All of them have been tried and found beneficial. So far as is known, their application on a large scale in public lakes is being carried on only in Michigan.

In the past two seasons (1930 and 1931) 112 lakes in various parts of the Southern Peninsula have been investigated. Of these, 82 are in Antrim and Kalkaska counties, 15 in Hillsdale County, and the remainder are widely scattered throughout the state. The Antrim-Kalkaska group is referred to as the "northern lakes," and the Hillsdale group as the "southern lakes." The following summary gives, in a general way, some of the conditions found in the lakes, some of the recommendations, and some of the problems encountered. The names, locations, and sizes of the various lakes are listed in Table I, on page 266.

INLETS AND OUTLETS

Connecting waters may affect a lake in several ways. Inlets which come from fertile waters enrich the bottom soils and may bring a continuous supply of vegetation for propagation. If they receive sewage in their courses, inlets may pollute the lake to the detriment of the fish population.

It is often helpful to prevent or to encourage the migration of fish through inlets or outlets. It is advisable to erect screens where trout streams enter warm lakes or where obnoxious fish are present in the lakes. Certain species which inhabit lakes

TABLE I

Location and Size of Lakes Examined

Name	County	Township	Range	Size in acres
Perch	Hillsdale	5 S.	1 W.	37.5
Moon	do.	5 S.	1 W.	31.7
Bawbees	do.	6, 7 S.	2, 3 W.	316
Second	do.	7 S.	3 W.	36
Third	do.	7 S.	2, 3 W.	35
Fourth	do.	7 S.	2, 3 W.	44
Boot	do.	7 S.	3 W.	64
Bird	do.	7 S.	2 W.	114
Bankers	do.	7 S.	3 W.	74
Wilson	do.	7 S.	3 W.	92
Bear	do.	7 S.	3 W.	104
Long	do.	7 S.	4 W.	213
Hemlock	do.	6, 7 S.	4 W.	146
Carpenter	do.	7 S.	4 W.	33.5
Berry	do.	7 S.	4 W.	22
Elk	Antrim and Grand Traverse	28, 29 N.	9 W.	7732
Round	Antrim, Kalkaska, and Grand Traverse	28 N.	8, 9 W.	2561
Torch	Antrim and Kalkaska	29, 30, 31 N.	8, 9 W.	18,286
Clam	Antrim	29 N.	8 W.	427
Bellaire	do.	29, 30 N.	7, 8 W.	1785
Central	do.	30, 31 N.	7, 8 W.	1515
Bass	do.	29 N.	9 W.	124
Birch	do.	29 N.	9 W.	441
Mud	do.	30 N.	9 W.	66
High	do.	29 N.	9 W.	64
Thayer	do.	29 N.	8 W.	97
Lake of the Woods	do.	29 N.	7 W.	185

prefer to spawn in streams. If access to these is prohibited, such species reproduce poorly or not at all. The inadvisability of planting these fishes in lakes without inlets or outlets is apparent. Cold inlets may provide cool water, which is attractive to certain species. Intermittent inlets and outlets may change the temperature, water level, or chemical content.

The inlets and outlets of the Hillsdale lakes were found to be generally small and unimportant. Where large connecting passages existed the conditions in the connected waters were about the same and fish screens were not necessary. In the Antrim County chain, Torch, Elk, Round, Clam, Bellaire, and Central lakes, the connecting passages were extensively used by boats, and hence the trouble in maintaining screens would outweigh their usefulness.

TABLE II

Maximum Depths Found and Dominant Soil Types

Name	Maximum depth in feet	Dominant soil on shoal	Dominant soil beyond margin
Perch	10	sand, pulpy peat and fibrous peat	pulpy peat
Moon	36	marl	pulpy peat
Bawbees	71	marl	pulpy peat
Second	62	marl	pulpy peat
Third	13.5	marl	pulpy peat
Fourth	51	marl	pulpy peat
Boot	40	marl	pulpy peat
Bird	66	marl	pulpy peat
Bankers	45	marl	pulpy peat
Wilson	60	marl	pulpy peat
Bear	53	marl	pulpy peat
Long	45	marl	pulpy peat
Hemlock	65	marl	pulpy peat
Carpenter	40	marl	pulpy peat
Berry	28	marl	pulpy peat
Elk	198	sand	clay
Round	29	sand, pulpy peat and fibrous peat	clay
Torch	297	sand	clay
Clam	29	marl	clay
Bellaire	99	marl and sand	clay
Central	79	marl and sand	pulpy peat and clay
Bass	27.5	sand	pulpy peat
Birch	53	sand	pulpy peat
Mud	3	pulpy peat	pulpy peat
High	15	sand	pulpy peat
Thayer	18	sand	pulpy peat
Lake of the Woods	13.5	sand and fibrous peat	marl

DEPTHS

The Lake Survey divides lakes into four classes, on the basis of depths. It is probable that the greatest absolute depths were not found on the sounding courses, but variation is probably very slight. Maximum depths of the various lakes are listed in Table II.

The classification by depths is as follows:

(1) Very shallow lakes. These have a maximum depth of three or four feet. This extreme shallowness, together with organic bottom, renders such lakes unfit for fish life. Even if these lakes did not freeze solid in winter, the decay of the organic matter on the bottom would deprive the unfrozen water of its oxygen. Mud Lake in Antrim County is the only one of this type examined.

(2) Relatively shallow lakes. In this type no stratification of the water occurs, and both top and bottom temperatures are fairly high in the summer. These are suited only for warm-water fishes and are generally quite productive. There are a considerable number of such lakes.

(3) Relatively deep lakes with pulpy peat bottoms. In these the water is stratified so that the bottom temperatures are cold throughout the year. Most of the Hillsdale lakes, and Bass and Central lakes in Antrim County, are of this character.

(4) Deep lakes with bottom soils other than peat. In these the depths reach as much as three hundred feet and the water is definitely stratified. Torch, Elk, and Bellaire lakes in Antrim County fall into this classification.

The significance of the depth must be considered in relation to other factors. In the third class, depths of over forty to fifty feet are relatively unimportant, whereas in the fourth class the deep waters are of considerable value. These points will be discussed later in connection with oxygen.

BOTTOMS AND BOTTOM SOILS

The character of the bottom soils, especially in the submerged shelf area, determines in a large degree the productivity of the lake

and is responsible for favorable or unfavorable spawning conditions. It is very important also in relation to the resort development on the lake shores.

In the Hillsdale County lakes, with one exception, the shelf area is chiefly marl and the bottom below the shelf is pulpy peat. Most of the bays have a fibrous peat bottom. In the northern lakes of all depths the bottoms are of clay, pulpy peat, marl, or sand. The depths of the northern lakes are no indication of the character of the bottom soil. Little Twin Lake has a sand bottom even at its maximum depth, which is about forty feet. Big Blue and other lakes of depths up to ninety feet have marl bottoms even in their deepest parts. Lake Misch (Douglas), in Lapeer County, is the only one having a bottom composed principally of fibrous peat. This is an artificial lake produced by damming the drainage stream of a swamp; it has been in existence less than ten years. The Lake Survey has found no natural lakes which have bottoms predominantly of fibrous peat. The character of the bottom soils of the various lakes is recorded in Table II.

VEGETATION AND SHELTER

Vegetation and shelter are considered simultaneously because the only extensive protection for the young fish is that provided by the weed beds. In the northern lakes, where the shores are wooded, some protection is afforded by "dead heads" and branches which have fallen into the water.

Weed beds are abundant on the slopes and in the bays of the southern lakes, but vegetation is usually sparse on the marl shoals. Both the northern and southern shallow lakes generally have abundant vegetation. The deep lakes, in comparison, generally contain vegetation in very small amounts; Torch Lake has only a few weeds, and Elk and Bellaire lakes have scanty vegetation. Weed beds not only provide shelter for young fish, but also furnish food and oxygen. If the amount of vegetation is too abundant, it may lower the supply of oxygen at certain times of the year.

Protection for young fish is essential, especially where food is limited and where predators are abundant. If natural cover is sparse, the use of brush heaps is recommended. Although no

particular arrangement of the brush is necessary, certain kinds of shelter are generally advised. One type is a rectangular frame of four logs on which the brush is nailed, stapled, or wired. An area in the middle of the brush is thus left empty. In lakes having few weed beds it is desirable that this space be filled with rich soil and planted with those aquatic plants which are best suited to the lake conditions. The planting of vegetation, except in the brush shelters, is not usually advocated because of the high cost and its present questionable success. It has been found that algae and insects collect on the brush shelters; thus the heaps provide both food and protection for the young fish. These brush shelters have proved to be very satisfactory, and their construction is urged wherever weed beds are not abundant on the shoals. The number of these to be constructed depends upon the amount of natural cover present.

SPAWNING GROUNDS

Whenever possible the nests of nest-building species are examined, their locations are mapped, and a description of nesting conditions is recorded. In the late summer such examinations cannot always be made, since the nests have been partly obliterated by wave action. Where nesting conditions are considered unsatisfactory and the bottom is sufficiently firm, the placing of gravel on certain areas of the shoals is recommended. In the southern lakes the nests were made on root tips or on snail shells, but in the northern lakes they were generally built on gravel and sand. Where the bottom is very soft and it is impossible to place gravel, stocking may be depended upon to keep up the fish population of the lake.

FERTILITY

No practical method of determining the fertility of lakes has been developed. Some idea of this may be obtained from a study of the kind of bottom, the amount of food and vegetation present, and the surrounding shore soils. Shallow lakes with peat bottoms are usually fairly productive. The use of commercial fertilizer on the shoal areas has been advocated as an experiment in several

small, infertile, landlocked lakes in Kalkaska County. Ordinarily such fertilizing would be too expensive to be recommended extensively. Local fertility increase by adding rich soils in the brush shelters is advisable for lakes with barren shoals.

FOOD

A careful and reliable analysis of the food content of a lake, involving plankton counts, bottom fauna counts, and other examinations, cannot be made because of the limited time available for the inventory of each lake. Although more detailed study of food probably will be made in the future, at present the estimates are based on the relative abundance of minnows and insects and a study of the abundance and rate of growth of the fishes. An increase in shelter, vegetation, and fertility would naturally increase the food content of a lake.

In lakes in which no minnows are found, or in which the more desirable species of minnows do not occur, their introduction is recommended. The blunt-nosed minnow and certain other species of forage fishes spawn on the under sides of submerged objects. In certain places the submerging of slabs or boards on the shoals is advised. Such slabs provide proper spawning places for these species.

Occasionally rich ponds are adjacent to infertile lakes. Where such construction is practical, the digging of connecting channels is urged. One has been constructed at Bear Lake in Kalkaska County.

TEMPERATURE AND CHEMICAL CONDITIONS

A study of temperatures and certain chemical conditions is necessary to determine which species of fish should be planted in various lakes. Usually the upper twenty to thirty feet of water is warm and the lower levels are cold. Lakes with this cold, deeper water are suited for the cold-water species, provided sufficient oxygen is present.

Tests reveal adequate oxygen in the warm, circulating upper layer of all lakes. Cold-water lakes with bottoms of pulpy peat have little oxygen below the thermocline. In the deeper lakes

with clay bottoms sufficient oxygen was present at all depths. Tests were also made for carbonates, bicarbonates, carbon dioxide, acidity, and turbidity. All the lakes except High Lake in Antrim County were found to be alkaline in reaction. This single exception was acid.

Considering both temperature and oxygen, only three of the lakes examined in 1931, Torch, Elk, and Bellaire, were judged to be well suited for such cold-water species as lake trout, cisco, or whitefish. These species have been reported in a few other lakes, but are not common.

PREDATORS

Examinations for the various predators shows that long-nosed gar, short-nosed gar, dogfish, mud pickerel, and turtles are fairly abundant in the southern lakes, whereas few very undesirable predatory fishes or turtles are numerous in most northern lakes. Fish-eating birds are abundant in the southern part, but are not common in the north. Where gar or dogfish are abundant control is highly desirable. Night spearing and surface netting are recommended in such instances. Both these operations must be carried on under the supervision of the Department of Conservation. In Hillsdale County spearing parties organized by a conservation officer were found to be very successful.

It is to be remembered that many game fishes are predatory or cannibalistic. Where cover is poor they may destroy large numbers of small game fishes. Thus far the recommendations regarding predators have been made only for the protection of young fishes and for the removal of obnoxious fishes, but it is possible that in the future it will be advisable to recommend the control of other kinds. Most fish-eating birds are now protected by law, and it is possible that their esthetic value may balance their destructiveness. At least this value must be remembered in control work. The proper status of the snapping turtle as a predator has not yet been determined. It is well known that it removes fish from nets, but whether or not it is able to capture fish to any great extent under natural conditions remains to be proved. Water snakes are found on many of the lakes, but they

are not very abundant and they probably do little damage. The Institute for Fisheries Research is now making studies of the stomach content of most of the aquatic predators, and the recommendation of certain control measures awaits the results of this research.

FISH POPULATION

No practical method for determining the fish population of a lake has yet been devised. The number of small fish taken per square yard in seining and the number in nets per hour give a fair idea of the relative abundance. These methods, however, are somewhat inaccurate. The weather, time of day, and agility of the various species all influence the catch. It is possible, however, to determine which species are abundant, which are common, and which are rare. The species of fish which were taken or reported from each lake are shown in Table III. Nets are set only often enough to determine which species are present, and to get some idea of their abundance. Excessive netting would tend to reduce the fish population too much. It is probable that the Lake Survey party did not obtain specimens of every kind of fish in any particular lake, but the species not secured are so rare that their presence could not influence the rest of the fish population to any appreciable extent. A separate card is made for each net set or seine haul. It states the kind of equipment used, the time of day, weather conditions, vegetation, kind of bottom, and the number and sizes of the various species taken.

Before recommending which species and what numbers of fish should be planted in any lake a careful study must be made of the environmental factors. Most of these are mutually interrelated and a change in one may affect others. A change in the fish population of a lake, induced by planting certain species, may upset the balance of nature and result disastrously for desirable species or for all the fish in a lake. After all the material is evaluated it is possible to recommend a program of stocking which should produce desirable results.

TABLE III

SPECIES OF FISH TAKEN OR REPORTED FROM the VARIOUS LAKES
+ = Present; R = Reported, but not taken

NAME	Perch	Moon	Bawbees	Second	Third	Fourth	Boot	Bird	Bankers	Wilson	Bear	Long	Hemlock	Carpenter	Berry	Elk	Round	Torch	Clam	Bellaire	Central	Bass	Birch	Mud	High	Thayer	Lake of the Woods
GAME AND PAN FISH																											
Brown trout	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	R	..	+	..	..	..	..	..	..	..	..	+
Lake trout	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
Brook trout	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..
Mud pickerel	+	..	+	..	..	..	..	+	..	..	..	+	..	..	..	+	+	..	+	+	+	+	+	+	..	..	..
Northern pike	..	+	+	+	+	+	..	..	..	..	..	..	..	..	..	+	+	+	..	..	+	+	+	+	..	..	..
Muskellunge	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Perch	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	R	+	+	+	+	+	+	+	+
Wall-eyed pike	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Small-mouth bass	..	..	R	..	..	..	..	..	..	..	..	..	..	R	..	+	+	+	+	..	+	+	+	..	..	..	..
Large-mouth bass	+	+	+	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	..	..	..	..
Warmouth bass	..	+	+	..	+	+	+	+	+	..	..	+	+	..	+	..	..	..	+	..	..	..	+	..	..	..	..
Green sunfish	..	..	+	..	+	..	+	..	..	..	..	+	+	+	..	..	..	..	+	..	+	+	..	..	..	..	..
Bluegill	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	..	..	..	+	..	+	+	+	+	..	..	..
Long-eared sunfish	..	..	..	..	..	..	..	+	+	+	..	+	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Pumpkinseed sunfish	+	+	+	+	+	..	..	+	..	+	+	+	+	+	..	+	+	+	+	+	+	+	+	+	..	..	..
Rock bass	..	..	+	..	..	+	+	..	+	+	+	+	+	..	..	+	..	..	+	..	..	..	..	..	..	..	..
Black crappie	..	..	..	..	+	..	..	+	+	..	+	+	..	..	..	..	..	R	..	R	..	..	..	..	..	..	..
Whitefish	..	..	..	..	..	..	..	..	R	..	..	R	..	..	..	+	..	+	..	+	+	..	..	..	..	..	..
Cisco	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
COARSE FISH																											
Common sucker	..	..	..	..	..	..	..	+	+	..	..	+	+	+	..	+	+	+	+	+	+	..	..	..	..	+	..
Lake chub sucker	..	..	..	..	..	..	+	..	..	..	+	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Mullet	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Black bullhead	..	..	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..	+	..	..	..
Brown bullhead	..	..	..	+	+	+	..	+	..	..	+	..	+	+	..	+	..	..	..	..	..	..	..	..	..	..	..
Yellow bullhead	+	+	+	+	+	+	+	+	+	+	+	+	+	..	..	+	..	..	..	..	..	..	..	..	..	..	..
Catfish	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
OBNOXIOUS FISH																											
Short-nosed gar	..	..	+	+	..	+	..	..	..	..	..	+	+	..	..	R	+	..	+	+	+	..	..	..	..	..	..
Long-nosed gar	..	..	+	+	..	..	..	..	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dogfish	..	+	+	+	+	+	+	..	..	..	..	+	..	..	..	R	..	+	..	..	..	..	..	..	..	..	..	..
Lawyer	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Name	Perch	Moon	Bawbees	Second	Third	Fourth	Boot	Bird	Bankers	Wilson	Bear	Long	Hemlock	Carpenter	Berry	Elk	Round	Torch	Clam	Bellaire	Central	Bass	Birch	Mud	High	Thayer	Lake of the Woods
FORAGE FISH																											
Black-nosed shiner	+		+		+		+	+			+			+		+											+
Black-chinned shiner	+		+		+		+	+			+			+		+											+
Mimic shiner	+		+		+		+	+			+			+		+											+
Straw-colored shiner	+		+		+		+	+			+			+		+											+
Common shiner	+		+		+		+	+			+			+		+											+
Golden shiner	+		+		+		+	+			+			+		+											+
Blunt-nosed minnow	+		+		+		+	+			+			+		+											+
Tadpole cat	+		+		+		+	+			+			+		+											+
Mud minnow	+		+		+		+	+			+			+		+											+
Menona killifish	+		+		+		+	+			+			+		+											+
Black-banded top minnow	+		+		+		+	+			+			+		+											+
Log perch	+		+		+		+	+			+			+		+											+
Johnny darter	+		+		+		+	+			+			+		+											+
Iowa darter	+		+		+		+	+			+			+		+											+
Least darter	+		+		+		+	+			+			+		+											+
Silversides	+		+		+		+	+			+			+		+											+
Muddler	+		+		+		+	+			+			+		+											+
Stickleback	+		+		+		+	+			+			+		+											+
Rosy-fronted minnow	+		+		+		+	+			+			+		+											+
Lake shiner	+		+		+		+	+			+			+		+											+
Long-nosed dace	+		+		+		+	+			+			+		+											+
Horned dace	+		+		+		+	+			+			+		+											+
Black-nosed dace	+		+		+		+	+			+			+		+											+
Rainbow darter	+		+		+		+	+			+			+		+											+
Steel-colored minnow	+		+		+		+	+			+			+		+											+
Stone roller	+		+		+		+	+			+			+		+											+
Black-cheeked top minnow	+		+		+		+	+			+			+		+											+
Pug-nosed shiner	+		+		+		+	+			+			+		+											+
Pirate perch	+		+		+		+	+			+			+		+											+

ENVIRONMENTAL CONTROL AS A METHOD IN CONSERVATION

It is not intended that environmental control should take the place of stocking. It should bring about wiser and more effective stocking. Stocking alone has been unable to meet the continuously increasing drain on fish by sportsman and tourist. We believe that environmental control measures, if properly carried out, will help to do this. Such work in Michigan lakes is still too new to enable us to say with accuracy how much the fish populations can be increased. The lakes on which improvements have been made are being carefully checked. The results of observations already made, together with a realization that the improvements recommended are practical and sound, permit us to look ahead toward better fishing in this state with more than a little optimism.

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FIG. 1. Plane-tabling

FIG. 2. Detailing shore line

FIG. 3. Water analysis

Bawbees Lake, Hillsdale Co., Michigan

FIG. 1. Dredging bottom soil

FIG. 2. Seining

Bawbees Lake, Hillsdale Co., Michigan

A NEW POPULATION MAP OF MICHIGAN, 1930

FLOYD A. STILGENBAUER AND HENRY VOZKA

THE function of a population map is to give a correct impression of the areal distribution, density, agglomeration, and group relationship of people. In Michigan, as elsewhere, people are distributed in accordance with the ability of the numerous environmental complexes to provide as many different settings of natural and cultural conditions by which man may obtain varying degrees of livelihood. Deeply rooted in the utility of her resources, Michigan's population pattern is mature in form, and relative density and sparsity will definitely remain as now pictured. Local and general changes in density are to be expected as the demand, supply, and utility of the state's resources fluctuate with powers uncontrolled or beyond the control of man. In the last decade the total population was increased by 32 per cent, and the pattern has changed only a little, but the density has increased in more than half of the counties of the state by amounts as great as 134 per cent. A few counties in the cut-over areas decreased in density as much as 31 per cent. During the depression of 1931–32 there was a notable tendency for unemployed people to migrate to the rural sections surrounding the larger urban centers, to await the return of industrial prosperity and the higher wages paid for city services.

Population density changes by accretion or natural growth of groups and their decretion or natural shrinkage. From earliest times it has been the tendency of people to live in groups ranging from the single-family type to the multiple-family agglomerations existing in our modern urban centers. The major problem in the construction of a population map of Michigan (Map 25) is to devise a scale that will represent distribution and, at the same time, show clearly the density, which varies from 3,046 people

Map 25

per square mile in Wayne County to 3 per square mile in Oscoda County. A dot-and-circle method of presenting population distribution is, we believe, the best means by which concentration and sparsity can be shown with a minimum of error in conception. Exclusive of rural generalization, this system permits naturalness, accuracy, and clearness of representation for distribution and density on the finished map.

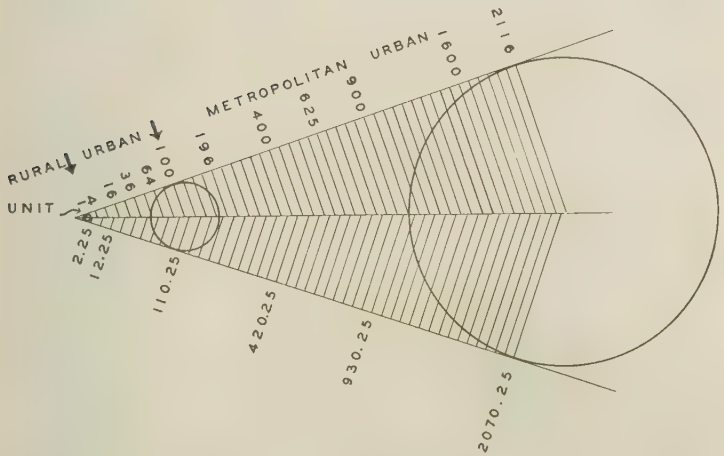
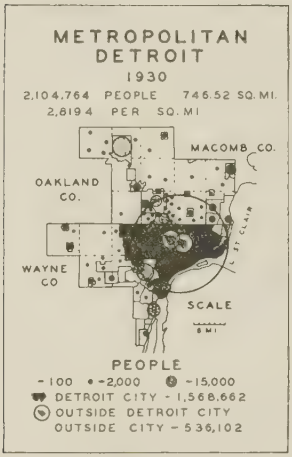


FIG. 7. On the tangents of the scale each successive radius is increased by one thirty-second of an inch, beginning with a length of one thirty-second on the upper tangent and one sixty-fourth of an inch on the lower. On the common secant each successive radius is increased by one sixty-fourth of an inch. To find the population value of the radius of any circle in thousands of people, square the number of thirty-seconds of an inch or fraction thereof in the length, as 1^2, 2^2, 3^2, 4^2, etc., for the upper side; and $(\frac{1}{2})^2$, $(1\frac{1}{2})^2$, $(2\frac{1}{2})^2$, etc., for the lower side. Scale divisions may be further subdivided into smaller units

The unit dot selected for the original scale is one sixteenth of an inch in diameter and represents 1,000 people uniformly distributed in family groups having approximately two acres for garden and building space to meet the single-dwelling type of habitation (Fig. 7). By this unit, which gives the medium between simple rural and complex urban habitation, we measure all groups on a common basis of similar area in relation to the number of people,

with a base map of sixteen miles to the inch. For instance, if the 526,191 average family groups (four persons to a family) of Greater Detroit were each allotted an amount of land as determined by the scale, they would require the area shown by the largest circle on the map. The 10,893 average family groups of Battle Creek are represented by a proportionately smaller circle, and so on through the list of towns and cities of the state. By the use of the proportionately smaller unit dot the rural population is mapped by generalizing smaller groups into groups of 1,000 people each.



Map 26

Scale divisions, to the cartographer, are only arbitrary and are for the convenience of map interpretation only. Population growth is transitional, as may be seen by comparing the stages of growth reached at periodic intervals. Detroit began with the settlement of a few families and, with superior natural conditions for growth and expansion, has developed into the complex metropolitan area of today (Map 26), surpassing all other urban centers of the state. From the foregoing principle of natural growth a scale was constructed for the new population map of Michigan (Fig. 7). In the scale shown here each radius was increased by one sixty-fourth of an inch. The smallest conceivable difference between circles representing population groups may be obtained by subdividing the spaces between the respective radii.

Three symbols have been used in the construction of the population map of Michigan (Map 25). Small black dots equal to 1,000 inhabitants picture the rural distribution. They are placed to represent correctly the actual distribution and density by townships. Urban centers are represented by hollow shaded circles symbolizing groups of 1,000 or more, with the radius of each circle determined by the size of the group. Where the circle of

population covers more area than is embraced by the urban political unit, the approximate city area has been colored black.

Any representation of population within the actual political boundaries of a central city gives an inadequate picture of the urban center, since most urban agglomerations show considerable expansion beyond the periphery of civil organization. Suburban groups are geographically a part of the urban growth, although not politically united with the central city. Most of the suburbanites are employed directly or indirectly in the social and economic activities of the city proper and must, therefore, be classed as part of the urban district. Because of this condition the United States Bureau of Census found it necessary to recognize metropolitan districts. Metropolitan districts were created for all cities in the United States having more than 100,000 inhabitants. In Michigan only Detroit, Grand Rapids, and Flint have sufficient inhabitants to be mapped as metropolitan cities.

Some generalization of scale symbols is necessary in order to picture correctly the population of an entire state. The foregoing method of presentation provides for variations by combining the symbols in the manner needed for clarity, and yet at no great sacrifice of accuracy. Generalizations are made only when the rural population is in groups of less than 1,000 people. Otherwise, thousands of tiny dots of varying size would appear on the map to confuse the reader. When rural populaton is medium to dense, generality tends to lend clarity and hence accuracy of expression.

In constructing a population map an accurate tracing is made of an outline map that gives county and township boundaries. All cities of 1,000 or more people are then carefully located in their exact positions and indicated with a circle according to the scale. Rural dots are then placed in each township as nearly as possible in accordance with the distribution when all natural and cultural factors are considered. Railroad lines, bodies of water, and rural hamlets are kept especially in mind in placing the dot. With the symbols placed where people are known to dwell, there are apparently no interferences to impair a correct impression of the population distribution, density, and group relationship of any part of Michigan.

The criteria for the establishment of metropolitan districts was taken from the United States Bureau of the Census as follows: "The metropolitan districts for the Census of 1930 include, in addition to the central city or cities, all adjacent and contiguous civil divisions having a density of not less than 150 inhabitants per square mile, and usually any civil divisions of less density that are directly adjacent to the central cities, or are entirely or nearly surrounded by minor civil divisions that have the required density." In view of the high density about the Detroit metropolitan district the unit value had to be placed as high as 1,000 people in order to avoid obscurity of symbols.

The Detroit metropolitan area (Map 26) consists of all townships in Wayne County that are along the base line or northern limit; and in addition, the following: Nankin, Dearborn, Ecorse, Monguagon, Grosse Isle, Gratiot, and Grosse Pointe. Also, the seven southeastern townships of Oakland County as well as Sterling, Clinton, Warren, Lake, and Erin townships of Macomb County are included. The cities of Detroit, Dearborn, Highland Park, Hamtramck, Lincoln Park, River Rouge, Wyandotte, Pontiac, Royal Oak, Birmingham; and the villages of Northville, Plymouth, Grosse Pointe, Bellville, Ferndale, Pleasant Ridge and several others, form a part of the metropolitan district. Grand Rapids and Flint are located near the center of a block of four adjacent townships which comprise their metropolitan districts (Map 25).

Three kinds of error which cannot be completely eliminated present themselves in the construction of a population map according to the foregoing scale. They are: (1) mechanic, due to instruments, measurements, and the like; (2) conception, due to human weakness in registering a mental impression of exact quantities of area with small differences in value; and (3) misplacement of symbols, due to generalizing the smaller scale values. Errors of the first and second types increase down the scale, and below the circle equal to 1,000 people become so great as to force generalization, which introduces a possible third error of misplacement. If the mechanic is below the true amount and the conception above, they tend to cancel each other, but if both are

above or both below, the amount of error increases. Generally, the construction is more than 90 per cent correct in the presence of these unavoidable errors.

The finished map (Map 25) shows a concentration of population, both urban and rural, in the southern half of the Southern Peninsula (approximately 74 per cent) and a sparsity which begins north of an east–west line from Bay City to Muskegon. Forty-three per cent of the total state population is in the Detroit metropolitan district. Furthermore, by totaling the population of Wayne, Kent, Saginaw, Genesee, Ingham, and Oakland counties, over 57 per cent of the total state inhabitants have been tabulated. These political units include the largest urban centers of the state, and consequently a large percentage (71) of their population is urban.

There is a tendency for the urban population of the Southern Peninsula of Michigan to be arranged in a semiradial pattern, with Detroit acting as the focal point. Pontiac, Flint, Saginaw, and Bay City are concentrations along one of the major lines of population growth. Similar principal lines of growing concentration are Lansing, Grand Rapids, and Muskegon; also Dearborn, Ypsilanti, Ann Arbor, Jackson, Battle Creek, Kalamazoo, and Benton Harbor; and Wyandotte, Trenton, and Monroe. This radial pattern coincides with the old Indian trails, which are now paralleled by modern roads and transportation lines. The narrowness of the Great Lakes water route and the southward bend of the Detroit River helped to concentrate early trails at this location, where a crossing was most feasible. The high bank on the outside bend commanded the best view of the waterway, and the presence of a small stream (Savoyard Creek), for the mooring of canoes and the draining of the swamps, influenced the location of Fort Pontchartrain as the forerunner of Detroit.

A lesser area of urban concentration is manifest at points along the lake where favorable harbors like Grand Haven are located; where mineral deposits are extensive, as at Houghton or at Iron Mountain; where fruit and other farm produce are concentrated for shipment, as at Benton Harbor or South Haven; and where breaks or interruptions to transportation result, as at Sault Ste. Marie, Ludington, and Frankfort. The growth of resort sections

within the past few years has also stimulated city expansion along the shores of lakes.

Cut-over lands of relatively poor agricultural soil, such as that in Roscommon, Crawford, and Oscoda counties, explain, for the most part, areas of sparse population. Schoolcraft and Mackinaw counties are also lacking in suitable resources, at the present time, to attract settlers, whereas the western section of the Northern Peninsula still has large parts rather heavily forested. Concentration of inhabitants in the Northern Peninsula is in the mineral-producing districts and along the lines of transportation and communication. Marquette, Calumet, Houghton, Ironwood, Iron Mountain, Escanaba, and Menominee are primarily distributing centers serving the mining region. Considerable lumbering operations are also evident in Menominee, Escanaba, Gladstone, Manistique, and other centers of the Northern Peninsula that have access to the timber lands of the western counties and to transportation by the Great Lakes.

Since natural conditions favor industrial activities in much of Michigan, population continued to increase at the relatively rapid rate of 30 per cent during the last decade; at the end of that period there was a total of 4,842,325 people in the state, according to the census data of 1930. Population figures point to a marked industrial expansion around the periphery of Wayne County during the last ten years. Although Wayne still increased, the rate was not so rapid as in the surrounding counties. Lower real-estate values in the adjoining areas influenced, for the most part, industrial and urban expansion. The greatest increases occur along the principal lines of transportation and where favorable natural or economic conditions have operated. Many northern counties exhibit actual shrinkage in population. Unable to make a satisfactory living with the rapidly declining lumber industry and the poor agricultural soils of the cut-over lands, many inhabitants heeded the call of the urban industrial centers. The greatest losses are shown in Montmorency and Kalkaska counties.

Because of the mushroom growth, the natural focus of transportation lines, and the position on the international boundary Detroit has a notched, semicircular appearance. The six main

arteries focus at the heart of the present business district on Woodward Avenue. With the expansion of the city it has become more and more difficult for increasing numbers of people to transact their business in the commercial core, where narrow, diverging thoroughfares lead to great traffic congestion. Also, the outward expansion of the city has pushed suburban development farther and farther away from the down-town section. As a result, smaller business districts have developed along the arterial highways and important cross streets, indicating that Detroit is deteriorating within the heart of the city itself and giving rise to the recent expression, "Detroit is becoming rotten at the core."

PERCENTAGE OF VACANCY IN DETROIT MARCH, 1932

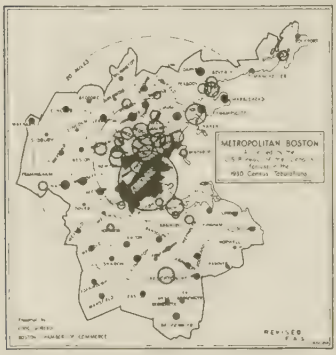
Woodward Avenue		Grand River Avenue	
Selden to Warren	32	Cass to Trumbull	26
Warren to Grand Boulevard	21	Trumbull to Grand Boulevard	16
Grand Boulevard to Joy Road	17	Grand Boulevard to Joy Road	6
Joy Road to Six Mile Road	14	Joy Road to Oakman	6
Six Mile Road to Eight Mile Road	17	Oakman to Lasher	8
		Lasher to Seven Mile Road	8

Michigan Avenue	
Cass to 14th	24
14th to Grand Boulevard	20
Grand Boulevard to Livernois	14

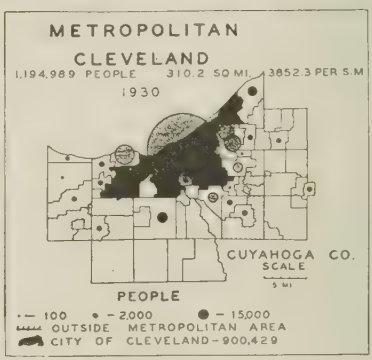
There has been a gradual outward movement of the population from the inner zone to the periphery. This is manifested by school census figures which, until 1930, showed a small increase in the inner wards and an increase sometimes amounting to 24 per cent in the outlying sections. During 1931 there was, however, a marked decrease in all wards, except in the extreme eastern and western parts of the city, but here the increase was less than 5 per cent. Although a growth in these districts was still indicated, it is negligible when compared with that of former years. From these statistics it might be concluded that many families have really left the city on account of the current business depression. It has been estimated by various authorities that the population of the city has actually decreased about 200,000 during the two years following the 1930 census enumeration. To secure confirmation

of this tendency a careful check was made of the business places on Woodward, Grand River, and Michigan avenues, from the inner core of the city toward the periphery. The results obtained are shown in the table on page 285.

The greatest losses are apparent within the district bounded by Grand Boulevard, and within this area the down-town or more focal section shows the greatest loss of business places. A



Map 27

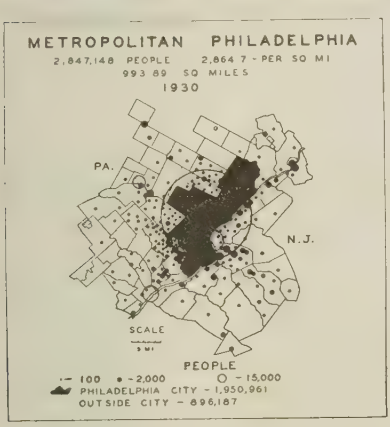


Map 28

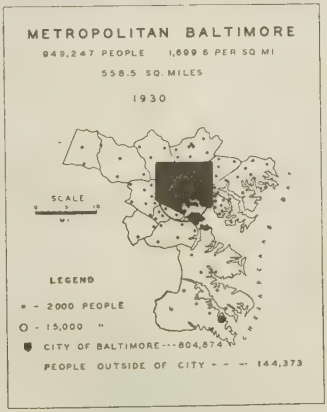
notable decrease in the vacancy percentage is encountered outside the commercial core. These facts again substantiate the statement that the inner sections of the city are deteriorating and that there is an outward shift of population. Probably many of the people have actually left the city on account of unemployment. From observations made in the residential sections a like tendency persists. Scores of homes and hundreds of vacant rooms, some of them unoccupied for months, are found in the decadent older residential sections about the inner core; but farther from the center of the city the more desirable homes, when vacated, are again soon occupied.

A comparison of the eleven leading cities of the United States brings out a number of interesting facts. Although Detroit is ranked as the fourth largest city in this country, it drops to sixth place when the population of metropolitan districts is considered rather than that found only within the city limits. Metropolitan

Los Angeles, with 2,318,526 inhabitants, and Metropolitan Boston (Map 27), with 2,307,879, supersede the Michigan city, which has only 2,104,764 in the metropolitan area. Ranking next to New York City in area, Pittsburgh is second with 1,626 square miles and Los Angeles is third with 1,474 square miles. Detroit is ninth with 746.52 square miles, whereas Cleveland (Map. 28) having



Map 29



Map 30

only 310.2 square miles, is the most compact metropolitan area of the leading eleven.

ELEVEN LEADING CITIES OF THE UNITED STATES

City	Population	Land area square miles	Population per square mile	Percentage population in central city
New York.....	10,901,424	2,514.11	4,336.1	63.5
Chicago.....	4,364,755	1,119.29	3,899.6	77.3
Philadelphia...	2,847,148	993.89	2,864.7	68.5
Los Angeles....	2,318,526	1,474.34	1,572.6	53.4
Boston.....	2,307,897	1,022.60	2,256.9	33.8
Detroit.....	2,104,764	746.52	2,819.4	74.5
Pittsburgh.....	1,953,668	2,626.05	1,201.5	34.2
St. Louis.....	1,293,511	821.54	1,574.5	69.2
San Francisco..	1,290,094	825.60	1,526.6	71.1
Cleveland.....	1,194,989	310.20	3,852.3	75.4
Baltimore.....	949,247	558.51	1,699.6	84.7

Detroit (Map 26), with 2,819.4 inhabitants per square mile, ranks fifth among the urban areas of our country in density, whereas Cleveland holds third position, followed by Philadelphia (Map 29). Baltimore (Map 30) has more than 84 per cent of its inhabitants within the central city, followed by Chicago (77.5%), then Cleveland (75.4), Detroit (74.5), and San Francisco (71.1). All these cities are located upon navigable waters, and urban expansion has not been equal in all directions. Consequently, people have remained within the central city. Boston, with only 33.8 per cent of the people within the city limits, expanded outwardly because of favorable geographic conditions.

From indications in the Detroit area it is evident that the urban centers of our state are shrinking in size, with the inhabitants leaving for the better agricultural sections or places where taxes are not quite so high as in the industrial cities. In the case of Detroit this overexpansion, due to mushroom growth, may be attributed to the industrial boom during years of prosperity. The *Fourteenth Census* showed an enormous increase in urban population, and though the 1930 *Census* still reports city growth, there has been an actual loss in urban communities during the last two years. This may be the beginning of a reversed migration, with the people again returning to rural areas because of economic conditions in the industrial centers.

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REPORT OF AN INVESTIGATION OF SYLVANIA ROCKS IN OIL WELLS OF THE MICHIGAN BASIN

STELLA WEST ALTY

THE Sylvania rocks of the Michigan basin outcrop only in the southeastern part of the area, but in recent years numerous oil wells in various other parts of the basin have encountered rocks which are considered to be of Sylvania age. Although in the south and east the Sylvania consists of highly siliceous sandstone, in the wells farther west and north it becomes more and more dolomitic and cherty and is with difficulty distinguished from the Lower Monroe beneath and the Upper Monroe above.[1]

An investigation of samples of deposits of the Sylvania from different wells has been undertaken to determine the heavy and light mineral content and to find whether the minerals have any distinguishing lithological features. The samples have been supplied through the kindness of the Geological Survey Division of the Department of Conservation of Michigan. Those examined are from wells in the counties of Ottawa, Mason, Oceana, Newaygo, Isabella, Kalamazoo, Livingston, and Wayne, and are chiefly from the Sylvania, but a few from horizons both above and below have also been treated.

As already stated, the Sylvania deposits range from sandstone to arenaceous dolomite, cherty dolomite, and shale. The only lithological features which such rocks may have in common are likely to be found in the *insoluble* minerals. Although in the dolomitic and shaly rocks such minerals form a very small fraction of the whole, yet they may include some distinguishing mineral

[1] Newcombe, R. B., "Depositional and Structural Features of the Michigan Synclinal Basin," pp. 87–89 of unpublished manuscript.

or minerals which will prove a connecting link between this type of deposit and the more arenaceous forms. For this reason, in the present work it is the insoluble minerals which have been examined in detail.

METHOD OF TREATMENT

The following treatment of rock samples was found, after some experiment, to be most satisfactory. Each specimen (40 -50 gr.) was placed in fairly strong hydrochloric acid and subsequently boiled to ensure complete removal of the dolomite. For most of the well samples very thorough treatment with acid was necessary to remove the large amount of lime and dolomite which they contained.

After the acid treatment the insoluble residue was carefully washed and dried, then screened through bolting cloth of 96 meshes per inch. This allowed grains of 0.21 mm. diameter to pass through. The resulting fine material was then separated by means of a heavy liquid (bromoform) into heavy and light fractions. These were examined microscopically and the minerals were identified and all characteristics of the insoluble residue as a whole were noted. Additional chemical or magnetic tests of some few minerals were made.

The list of minerals, which is given below, appears quite long; actually, the average mineral suite of most samples was rather restricted.

MINERALS FOUND IN THE WELL SAMPLES

Cubic	*Tetragonal*	*Hexagonal*	*Orthorhombic*	*Monoclinic*	*Triclinic*
Fluorite	Anatase	Apatite	Andalusite	Biotite	Kyanite
Garnet	Rutile	Calcite	Anhydrite	Epidote	Microcline
Magnetite	Zircon	Dolomite	Celestite	Hornblende	Plagioclase
Pyrite		Hematite	Hypersthene	Muscovite	
		Ilmenite		Orthoclase	
		Quartz		Titanite	
		Tourmaline			

Non-crystalline: Leucoxene, limonite, pyrolusite.

THE INSOLUBLE RESIDUES

In general, the insoluble residues varied greatly. Those of fine-grained dolomites or dolomitic shales in many places formed

only a very small percentage of the rock sample. In the sandy shales or sandstones insoluble material was, of course, plentiful.

One of the greatest difficulties arose from the abundance of certain minerals, viz. pyrite, anhydrite, celestite, and chert. One or another of these frequently occurred in such bulk as to form a large insoluble residue and to mask the presence of the rarer detrital minerals. Anhydrite was the most troublesome of these, for, contrary to expectation, it was found to be insoluble in strong hydrochloric acid even when boiled. In order to test its solubility in this acid, it was ground to a powder, whereupon it dissolved readily. Since this process involves grinding up all other minerals as well, it does not help to solve the difficulty.

Celestite sometimes plays the same rôle as anhydrite and is so predominant that it is difficult to detect other heavy minerals which may be present. In cases like these a large quantity of the heavy residue was examined in an effort not to miss other minerals present, but even so it is almost impossible to estimate with any accuracy the relative abundance of these other minerals.

Pyrite is almost invariably present, and in the shales it sometimes occurs in great quantity, but it rarely forms so large a bulk as do the sulphates. Pyrite may be removed by warming the residue with dilute nitric acid, and this was sometimes done. The nitric acid may attack other minerals, and therefore the method is not altogether satisfactory.

Chert sometimes forms the greater part of the light minerals in the insoluble residue. If a clean specific gravity separation was obtained, chert did not appear among the heavy minerals, but in many cases was coated with minute pyrite crystals, and therefore sank in bromoform. In the light crop it sometimes obscures the characteristics of the quartz. The chert itself did not appear to possess any special features which might be useful for purposes of correlation.

DISTRIBUTION OF MINERALS

The insoluble minerals found in the different wells are listed in Chart I (Fig. 8), which shows their relative abundance in a qualitative way. A more quantitative method could not profit-

ably be employed because of the difficulty arising from the preponderance of anhydrite, celestite, and pyrite.

Minerals are to be sought which may be of value for correlation throughout the area. Those which are of secondary origin, such as anhydrite, celestite, pyrite, etc., are not likely to be very useful for this purpose. It is the primary detrital minerals which were deposited contemporaneously in Sylvania times which may be expected to have features in common. Chart I shows, however, that there are only a few of the primary heavy minerals in the Sylvania. Zircon, tourmaline, and hornblende are the only ones which have a widespread distribution. Fluorite, garnet, hypersthene, and epidote occur here and there. The latter two may prove characteristic. Hypersthene is a rather unusual mineral in sediments.

The presence of authigenic tourmaline as a secondary growth upon tourmaline grains which are of primary origin is a very interesting feature. It may prove to be characteristic of one particular area or rock. (See "Authigenic Tourmaline" on page 298.)

The quartz grains show some variation in character. This is in process of investigation. Those of the Sylvania sandstone, as

LOCATIONS OF WELLS

Key to the roman numerals at the bottom of Chart I (Fig. 8)

I. Ashland, Newaygo County. Brydges No. 1. SW. ¼ of Section 12, T. 11 N., R. 13 W.

II. Walkerville, Oceana County. Bert Snow No. 1. NW. ¼ of the SW. ¼ of Section 23, T. 15 N., R. 15 W.

III. Logan, Mason County. Young No. 2. SW. ¼ of SE. ¼ of Section 9, T. 17 N., R. 15 W.

IV. Agnew, Ottawa County. Paul Sako No. 1. NE. ¼ of the NE. ¼ of Section 27, T. 7 N., R. 16 W.

V. Chippewa, Isabella County. Reem A No. 6. S. ½ of SE. ¼ of Section 12, T. 14 N., R. 3 W.

VI. Alamo, Kalamazoo County. Bert Caldwell No. 1. NW. ¼ of the SW. ¼ of Section 32, T. 1 S., R. 12 W.

VII. Fowlerville, Livingston County. Ross Robb No. 1. SE. ¼ of SE. ¼ of Section 26, T. 4 N., R. 3 E.

VIII. Wyandotte, Wayne County. J. B. Ford No. 23. T. 3 S., R. 11 E.

CHART I

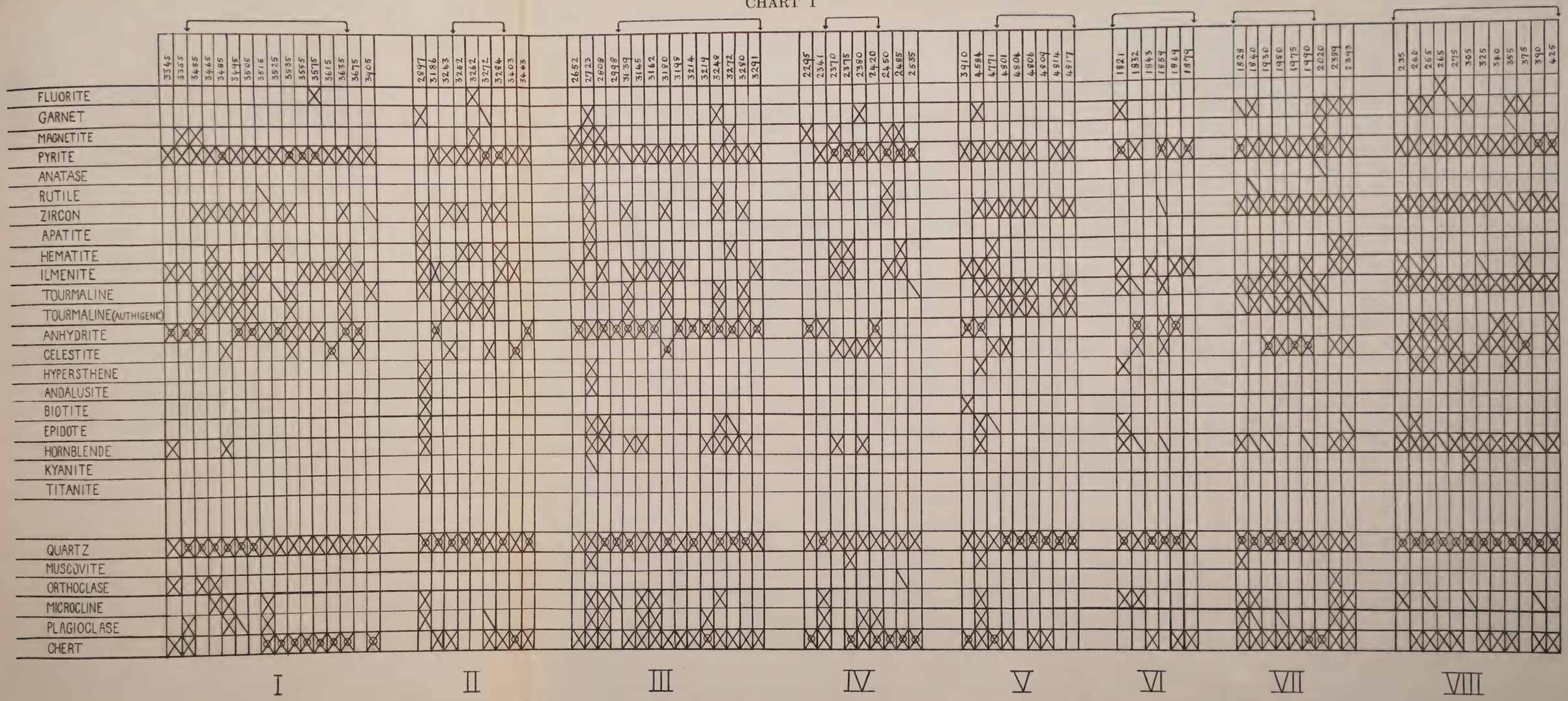

FIG. 8. Insoluble minerals found in Sylvania rocks in oil wells of the Michigan Basin. The minerals of the heavy and light fractions are shown separately and are arranged alphabetically in their crystal systems.

The brackets at the top of the table indicate the limits of the Sylvania rocks in each well. The roman numerals beneath the table refer to the various wells, the locations of which are given at the bottom of the opposite page. A cross (×) indicates the presence of a mineral at the locality and depth given; a cross through a circle (⊗), that the mineral occurs in great abundance and forms the larger part of the fraction in which it appears; an oblique line (\), that only one grain of a mineral was observed.

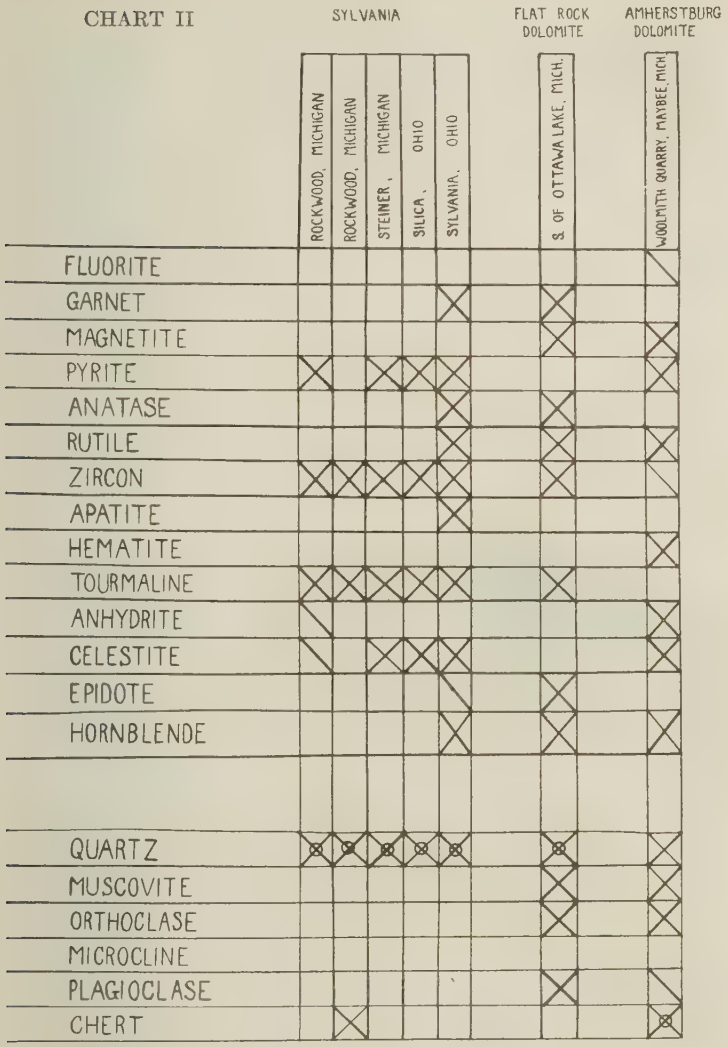

FIG. 9. Fragments of Sylvania sandstone from various localities. For explanation of arrangement and symbols see the caption of Figure 8.

typically developed, are markedly well rounded and many are frosted on the surface. In the well samples examined the shape varies a good deal; both rounded and subangular grains occur in many of them. In one or two places, in the western part of the area, the quartz suddenly appears very angular, in noticeable contrast to that in the samples described above. Moreover, this angular quartz contains as inclusions clear cubes of fluorite and somewhat rounded grains of apatite. These inclusions have not been found in the more rounded quartz of other samples. If this type of grain can be found in other wells it should prove very useful.

An important feature has been noted in the three wells from which samples from several hundred feet above what is considered to be the Sylvania have been analysed. In each case a clearly marked horizon appears in the Detroit River Series at somewhere about three or four hundred feet above the Sylvania rocks. The samples at this horizon yield a rich suite of abundant heavy minerals, viz. garnet, zircon, tourmaline, hypersthene, andalusite, biotite, epidote, hornblende, etc., whereas microcline and plagioclase feldspars characterise the light minerals. (See Chart I: Column II at 2,897 feet; Column III at 2,723 feet; Column V at 4,584 feet.) The striking features of this horizon cannot be indicated adequately in Chart I, but the mineral content as a whole presents several very distinctive features. Hornblende is the most common of the detrital minerals, but garnet, zircon, epidote, and hypersthene are also abundant. In all other samples the latter two minerals occur only as isolated grains. Tourmaline is rather scarce, and there is no sign of the authigenic tourmaline which appears lower down in the same wells in the Sylvania rocks. Among the light minerals microcline is remarkably and unusually abundant, being far more common than in any other well samples. There is every reason to believe that these minerals mark a definite horizon or division of the Detroit River Series, and it is hoped that further work will lead to its discovery in other wells. It should prove a very useful "horizon marker."

SYLVANIA AND UPPER MONROE ROCKS FROM OUTCROPS

In view of the difficulty of recognising with absolute certainty the Sylvania horizon in many wells, it was thought desirable to know the mineral character of Sylvania sandstone as exposed in the southeastern part of the Michigan basin. A comparison of the mineral content of these rocks and that of the Sylvania from wells should prove instructive. In the same way the petrographic character of other members of the Monroe rocks from outcrops should throw much light on the problem of correlation by mineral content. A few rocks have been examined and are described below.

SYLVANIA SANDSTONE

The Sylvania sandstone has been described in considerable detail by Grabau and Sherzer,[2] who pointed out its purity, the roundness and frosted surface of its grains, and other characteristics. They did not describe any heavy minerals, but stated that "Grains of minerals other than quartz are relatively infrequent." [3]

In the present work fragments of Sylvania sandstone collected from several localities (see Chart II [Fig. 9]) by Dr. C. B. Slawson have been examined. The same method of treatment as for the well samples was followed; the dolomitic or calcareous cement was dissolved out by treating with hydrochloric acid and the insoluble residue separated by means of bromoform. The following minerals were found:

Cubic	*Tetragonal*	*Hexagonal*	*Orthorhombic*	*Monoclinic*
Garnet	Anatase	Apatite	Celestite	Epidote
Pyrite	Rutile	Calcite		Hornblende
	Zircon	Dolomite		
		Ilmenite		
		Quartz		
		Tourmaline		

The distribution of the insoluble minerals in the various localities is shown in Chart II. An interesting point may be noted

[2] Grabau, A. W., and Sherzer, W. H., "The Monroe Formation," *Mich. Geol. and Biol. Surv.*, Publ. 2, Geol. Ser. 1, p. 77. 1909.

[3] *Ibid.*, p. 72.

here. The Sylvania from three localities, viz. Rockwood and Steiner, Michigan, and Silica, Ohio, contains very few heavy minerals — only pyrite, zircon, tourmaline, and celestite; the zircon and tourmaline are abundant and well rounded. In the two former localities heavy minerals are so rare that the heavy crop is almost non-existent; at Silica, Ohio, the same minerals were slightly more plentiful. At Sylvania, Ohio, a much more varied suite of heavy minerals appears: garnet, pyrite, anatase, rutile, zircon, apatite, ilmenite, tourmaline, celestite, epidote, and hornblende.

The roundness of the quartz grains in Sylvania sandstone has already been mentioned. An attempt was made to obtain the percentage of rounded grains. In the quartz assemblage from each locality a number of groups of 200 quartz grains were counted, and it was found that the really well rounded grains average in every case from 23 to 26 per cent of the total. This is for grains not exceeding 0.21 mm. in diameter; all the rock specimens, after crushing and treatment with acid, were screened through bolting-cloth of the same mesh (96 meshes per inch) as that used for the well samples. Naturally among the coarser grains there is a somewhat higher percentage of rounded grains.

No feldspar was observed at all. It is always possible that isolated grains may escape observation amongst so much quartz, but it is certainly not present in any appreciable quantity.

FLAT ROCK DOLOMITE

A specimen of dolomite kindly collected by Dr. R. B. Newcombe from south of the town of Ottawa Lake, Monroe County, was examined. This rock, Dr. Newcombe considers, is probably the Flat Rock dolomite of the Detroit River Series, but it *might* prove to belong to the Raisin River dolomite of the Lower Monroe. It is a fine-grained, creamy buff dolomite, with very little sign of arenaceous material in it. After prolonged treatment with acid a small quantity of creamy white sand was obtained. The mineral content is indicated in Chart II. It may be seen at once that the suite of minerals somewhat resembles that of the Sylvania from Sylvania. Minor points of difference are as follows: anatase is rarer

than in the Sylvania; hornblende is perhaps a little more common, whereas muscovite and small cleavage flakes of feldspar are present in the Flat Rock dolomite and absent from the Sylvania. The quartz of both rocks is similar; grains of equal size in both are well rounded, but the Flat Rock dolomite contains in addition a number of tiny grains and chips of quartz which are subangular or angular.

AMHERSTBURG DOLOMITE

A specimen of this dolomite was kindly collected for the writer by Dr. C. B. Slawson from Woolmith quarry, near Maybee, Monroe County, and was examined in the usual way. It is a tough, hard dolomite, which yielded only a very small quantity of fine-grained insoluble residue. The insoluble minerals are listed in Chart II. The insoluble residue as a whole was much obscured by limonite which, in spite of the treatment with acid, persisted as a staining on many of the grains. These opaque stained grains were in marked contrast to the clear and clean grains of the insoluble residues of the other rocks described above.

Green hornblende is much the most abundant of the heavy minerals of this rock; next to it, muscovite is perhaps the most characteristic, appearing with both light and heavy minerals. Isolated grains of rutile and zircon appear, and several iron ores. The quartz is rather fine grained and not very well rounded, but it is somewhat obscured by the abundant chert which appears in the light crop and which is much iron-stained.

Obviously, there is a marked difference between the insoluble minerals of the Amherstburg dolomite and the Sylvania sandstone. On the other hand, there is a great resemblance between the minerals of the Flat Rock dolomite and those of the Sylvania sandstone from Sylvania, and it is difficult to indicate distinguishing features, although the rocks themselves are quite different in character. At the same time the variety of heavy minerals occurring at Sylvania is so much greater than at the other three localities from which the Sylvania has been obtained that it might be suggested that there is a progressive decrease in heavy mineral content from the southeast to the northwest. In the well samples

there is some indication of slight differences between the east and the west sides of the basin, as may be observed in Chart I.

Other specimens of rocks of the Detroit River Series and of the Bass Island Series are to be examined in the course of the work. It is anticipated that the horizon will be found in the Detroit River Series, mentioned previously, where a specially varied group of minerals occurs, including hypersthene, epidote, microcline, and others. Further discussion of the results obtained from the well samples is postponed until this work shall have been completed.

AUTHIGENIC TOURMALINE

In a number of well samples unusual grains of tourmaline which have a curious colourless margin have been observed. This margin is like a "rim" or "frill" attached to an ordinary sub-rounded tourmaline grain. The latter is always coloured (brown, yellow, grey, or pink) and is strongly pleochroic, but the colourless rim is in perfect optical continuity with it and is, in fact, a secondary growth of colourless tourmaline around the original coloured grain. The colourless portion always occurs on one end of the *c*-axis of the tourmaline grain, and often shows striations on it parallel to this *c*-direction. Evidently these are the vertical striations which occur on many tourmaline crystals.

The authigenic character of the colourless portion of the grain can scarcely be doubted. The original tourmalines, which are nearly all rounded, were clearly deposited in the sediment before secondary crystallisation took place upon them. That the secondary tourmaline was deposited around the grain as an authigenic process within the sediment is plainly evident from the sharp angular edge of the secondary rim.

Tourmaline, though varying in composition in different varieties, almost always contains about 10 per cent of B_2O_3.[4] In connection with the possibility of secondary crystallisation, there at once arises the question of the source of the necessary boron. Without entering into a detailed discussion of the possible conditions under which authigenic tourmaline might be formed, it is

[4] Iddings, J. P., *Rock Minerals*, p. 425.

interesting to note a few points in connection with the formation of borates. They seem to have some application to conditions in the Michigan basin.

F. W. Clarke [5] states that certain borate localities are of volcanic and others of oceanic origin. Furthermore, marine deposits, he says, contain magnesium borates. A magnesium and calcium borate is cited as occurring at Stassfurt associated with anhydrite. These facts may have some bearing on the conditions which permitted secondary crystallisation of tourmaline in the Monroe sediments, although it is not suggested that the formation of authigenic tourmaline around minute and isolated grains is in any way comparable with the formation of borates. It may be noted, however, that in Lower Devonian times intermittent periods of desiccation and salt deposition took place in the Michigan basin. Perhaps a small quantity of boron was deposited in some form at the time and, being dissolved out later, was sufficient to supply the boron for the crystallisation of tourmaline.

The presence of authigenic tourmaline is indicated in a horizontal column in Table I. The mineral is seen at its best in well samples from the counties of Mason, Oceana, Newaygo, and Isabella. In the well samples from Livingston County grains showing authigenic tourmaline are rare, and the secondary portion of the grain is usually very small indeed. The majority of the tourmalines reveal no sign of secondary crystallisation. Furthermore, since authigenic tourmaline was not observed at all in the samples from the well in Kalamazoo County or from that in Wayne County, it is possible that the process of crystallisation developed best in the western and northern part of the basin and died out toward the south and east. If this is so, it may be significant that the formation of the mineral occurred within the area where dolomites are well developed and deposition of anhydrite was most common. It is to be noted that the rocks of the area are entirely sedimentary and that there is no evidence of volcanic or pneumatolytic action.

[5] Clarke, F. W., *Data of Geochemistry*, Second edition, *U. S. Geol. Surv., Bull. 491*, p. 239. 1911.

ACKNOWLEDGEMENTS

This work was commenced in the summer of 1931 in the Department of Mineralogy of the University of Michigan. Facilities for continuing it during the session of 1931-32 were kindly provided by the University of Saskatchewan.

The writer wishes to express her sincere gratitude to Professor W. F. Hunt for much assistance and advice, and to Dr. R. B. Newcombe for suggesting the problem and for much practical help in obtaining well samples and rocks. She is also indebted to Dr. C. B. Slawson for collecting rock specimens.

University of Saskatchewan
Saskatoon, Canada

SOME CHARACTERS OF THE SKULL AND SKELETON OF THE FOSSIL HARE, *PALAEOLAGUS HAYDENI*

LEE R. DICE

THE fossil hare, *Palaeolagus haydeni* Leidy, is still incompletely known, in spite of the fact that many fragments of its skull and skeleton have been collected from the White River beds of the Great Plains. These beds are considered to be Oligocene in age.

Associated with *Palaeolagus haydeni* in the White River beds are the remains of a very large hare of a distinct species, *Palaeolagus turgidus*. These two species of *Palaeolagus* are paleontologically the oldest known members of their order, the Lagomorpha. The fact that at its first known appearance in geological time the order is represented by two species, differing from each other in numerous characters, indicates that the Lagomorpha had a long previous period of evolution in Eocene time and perhaps earlier.

The Museum of Paleontology of the University of Michigan has two almost perfectly preserved skulls of the fossil hare *Palaeolagus haydeni*. Accompanying one of them are the complete mandible and most of the bones of the skeleton. A third specimen has the skull incompletely preserved, but several bones of the skeleton are in excellent condition. All these specimens were collected by expeditions of the University of Michigan from beds of White River age, four miles south of Douglas, Wyoming. They probably are from the Oreodon Zone. For permission to study this material I am indebted to Dr. E. C. Case, director of the Museum of Paleontology.

Skull 8942 (Pl. XXV) represents a very old individual with the molars much worn; the internal reëntrant angles have completely disappeared. The size of the skull is very small for a rabbit

(see Tables I–II), being smaller than that of the sage rabbit *Sylvilagus* (*Brachylagus*) *idahoensis*, which is probably the smallest living member of the Leporidae. The fossil skull also is considerably more flattened dorso-ventrally than is the skull of any living kind of rabbit or hare. Further, it is much less arched than the skull of any other genus of the Leporidae. The angle between the planes of the basioccipital and the palate is only 16.5 degrees.

TABLE I

Measurements of *Palaeolagus haydeni*, Skull 8942

	Mm.
Condylo-premaxillary length	44.6
Breadth across zygomatic processes of maxillae	24.6
Breadth across mastoid processes	22.9
Breadth of brain case	19.4
Depth of brain case	15.9
Interorbital constriction	6.5
Breadth of rostrum, just anterior to P^2	12.4
Depth of rostrum, just anterior to P^2	9.7
Breadth of both nasals	8.9
Depth of malar	4.0
Length of incisive foramen	11.8
Width of both incisive foramina	3.5
Length of bony palate	7.7
Condyle to incisive foramen	30.9
Palatine breadth, posterior to M^3	4.3
Length of auditory bulla	10.4
Diastema, upper jaw, on alveoli	10.0
Upper molar series, length on alveoli	11.9

A supraorbital process is present in *Palaeolagus haydeni*, but it is only slightly developed, consisting of a short tapering process, directed backward and outward. This process is somewhat imperfect in all the specimens, but it probably resembled that of *Romerolagus*, a member of the same subfamily, Palaeolaginae, living today on an isolated mountain mass in Mexico.

The bony palate in the fossil species is long as compared with those of modern hares and rabbits (Pl. XXVI, Fig. 1). It extends from about opposite the anterior edge of P^2 to opposite M^2. In modern *Lepus* the palate is shortened from both ends, extending in some species only from behind P^2 to behind P^4. The part

of the palate formed by the palatines has been especially reduced in the modern Leporidae, and, whereas in the fossil specimen the palatines form more than half the median length of the bony palate, in all modern hares and rabbits, so far as known, the palatines form less than half, and in some species they constitute only the narrow posterior edge of the palate.

Among modern leporids the genus *Romerolagus* is most like *Palaeolagus haydeni* in the structure of the palate. In *Pronolagus*, also, a relatively large proportion of the bony palate is formed by the palatines. Some individuals of the domestic rabbit (*Oryctolagus*) have the palatines forming nearly half of the bony palate, but in most individuals of this genus the palatines cover a much smaller area.

TABLE II

MEASUREMENTS OF *PALAEOLAGUS HAYDENI*, 14317

	Mm.
Mandible	
Length of mandible, posterior angle to end of incisor	39.9
Posterior coronoid process to end of incisor	38.8
Diastema, on alveoli	7.8
Skull	
Breadth of nasals	9.0
Length of zygoma	21.4
Interorbital constriction	8.4
Skeleton	
Length of tibio-fibula	56.3
Length of ulna (probably incomplete)	(40.0)
Length of radius	33.6

The palate is proportionately longer in the young of *Lepus* and *Sylvilagus* than in the adults, and in the young the palatines form a larger proportion of the palate. In this character the young resemble the primitive form.

The incisive foramina in the fossil skull extend forward between the posterior pair of upper incisors, differing in this respect from modern rabbits and hares, in which the foramina do not extend so far forward. In one of the figures (Fig. 2) of *Palaeolagus haydeni* given by Troxell [1] a similar condition is shown, whereas in

[1] Troxell, E. L., *Am. Journ. Sci.*, 1 (1921) : 340-348.

another figure given by him (Fig. 3) the foramina do not reach the incisors.

The width of the combined incisive foramina in the fossil is actually and proportionally much less than in any modern leporid. In this character *Palaeolagus haydeni* is most nearly like the Sumatran genus *Nesolagus* and the Indian form *Caprolagus hispidus*.

The posterior palatine foramina in the fossil are of about the average size for the family. In the related genus, *Romerolagus*, these foramina are relatively very large, but in *Pronolagus* they are very small.[2]

The posterior nares are narrow in the fossil, being smaller than in any wild member of the family which I have seen. But in the domestic rabbit the air passages are as constricted as in the fossil. On account of the small size of its air passages, *Palaeolagus haydeni* could have had only weak endurance in running.

The right mandible of specimen 14317 (Pl. XXVI, Fig. 2) is apparently perfect, and for the first time there is opportunity to determine the correct shape of the whole lower jaw. The posterior angle is long and pointed, and the specimen figured by Troxell [3] is thus shown to have been defective in this part. The posterior part of the mandible, though well provided with space for the attachment of the masseter muscles, is not nearly so well developed as in the hares of the subfamily Leporinae. The lower border of the mandible has no important downward development in the hinder third, as is true of *Lepus*, *Sylvilagus*, and their relatives.

The mandible of *Romerolagus* is closely similar to that of the fossil, differing chiefly in being somewhat larger and in having the vertical ramus higher in proportion to the length of the mandible. On the other hand, the mandible of *Alilepus annectens*, which I have also placed in the subfamily Palaeolaginae,[4] is much more like those of the Leporinae in type, as shown by the figure of the incomplete jaw published by Schlosser.[5] The posterior part of the mandible of this genus has a pronounced enlargement, such as

[2] Lyon, M. W., Jr., *Smithsonian Misc. Publ.*, 45 (1904) : 342.

[3] *Loc. cit.*, fig. 1.

[4] Dice, L. R., *Journ. Mammal.*, 10 (1929) : 340.

[5] Schlosser, Max, *Palaeont. Sinica*, Ser. C, Vol. 1, Fasc. 1 (1924), pl. 3, fig. 27.

is found in the genus *Lepus*. The genus *Alilepus* occurs in beds presumably of Pliocene or Late Miocene age in China and from its antiquity would be expected to be nearer to *Palaeolagus* in the character of the mandible than the published figure indicates it to be. *Alilepus* is considerably larger than either *Palaeolagus haydeni*

FIG. 10. Right scapula

FIG. 11. Right innominate

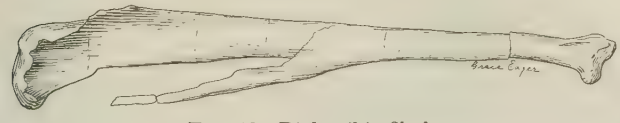

FIG. 12. Right tibio-fibula

Palaeolagus haydeni, Museum of Paleontology, University of Michigan, No. 14317. × 1½

or *Romerolagus diazi*, being closer in size to *Pronolagus*, a south African living genus belonging to the same subfamily.

The scapula is shorter and broader proportionately in the fossil than in any other known leporid (Fig. 10). Lying in the matrix posterior to the lower end of the scapula is a thin piece of bone, probably the metacromion, which is generally much elongated in the Leporidae. By the breaking away of the lower part of the spine of the scapula this piece of bone has lost its connection with the rest of the scapula. Compared with modern leporids, this metacromion is remarkably long for the size of the scapula.

The iliac wing of the innominate bone of the fossil (Fig. 11)

has a prominent keel on its exterior surface; this is distinctly more pronounced than in *Lepus* or *Sylvilagus*.

The ulna and the radius in both specimens 14317 and 14318 are fully separate, with no indication of fusion. The two bones are about equal in size. In modern *Lepus* the ulna is more slender than the radius and the two bones tend to fuse together.

The trochanters of the femur of the fossil are relatively undeveloped. The present specimen agrees closely with the figure given by Cope.[6] Compared with the femur of the California brush rabbit, *Sylvilagus* (*Microlagus*) *bachmani*, which is one of the smallest living rabbits, the first trochanter is very weakly developed, and the third trochanter and the minor trochanter are of only moderate size. The small size of these muscle attachments indicates that the animal must have had rather feeble jumping ability.

The tibia and fibula are fused at their lower ends, as in all modern rabbits (Fig. 12). The combined bone is relatively short for a rabbit, measuring only 56.3 mm. in total length in specimen 14317 and 53.4 mm. in 14318.

SUMMARY

Many of the characters of *Palaeolagus haydeni* are those to be expected in a primitive type of rabbit. Among simple characters exhibited by this fossil form may be mentioned small size, skull short in proportion to its length, skull relatively low and flat, plane of the occiput forming only a slight angle with the plane of the palate, supraorbital processes small and of a simple type; air passages small, palate long, enamel folding on the teeth simple, muscle attachments on the mandible and on the femur weakly developed. Notwithstanding its large number of simple characters *Palaeolagus haydeni* is characteristically a leporid, with the characteristic rabbit type of skull and skeleton and with the usual rabbit type of teeth, though with some minor differences in enamel pattern.

University of Michigan

[6] Cope, E. D., *Vertebrata of the Tertiary Formations of the West*, Book I, *Rep. U. S. Geol. Surv. Terr.*, Vol. 3 (1885), pl. 66, fig. 21.

PLATE XXV

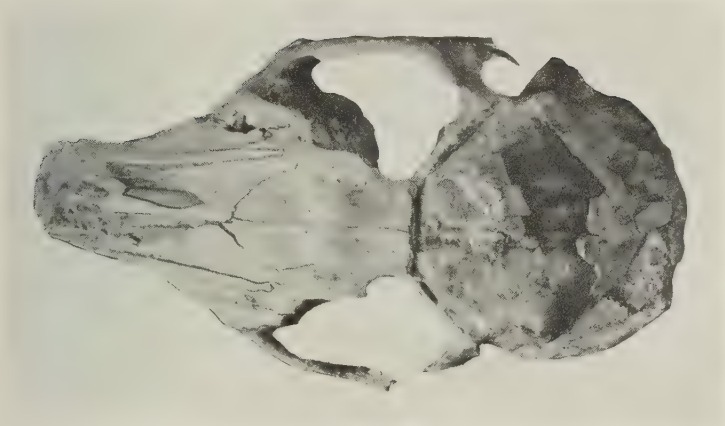

Fig. 1. Dorsal side of skull

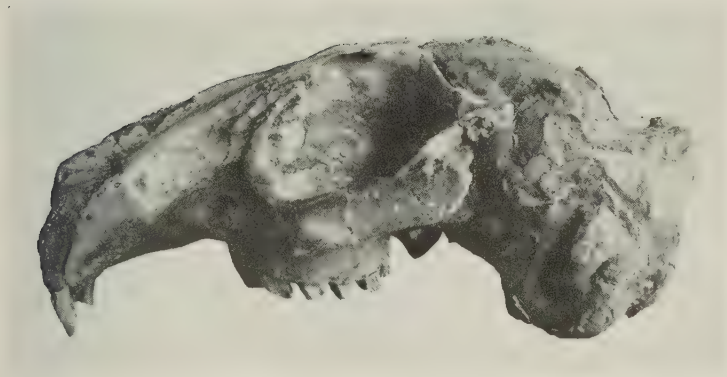

Fig. 2. Left side of skull

Palaeolagus haydeni, Museum of Paleontology, University of Michigan, No. 8942. × 2

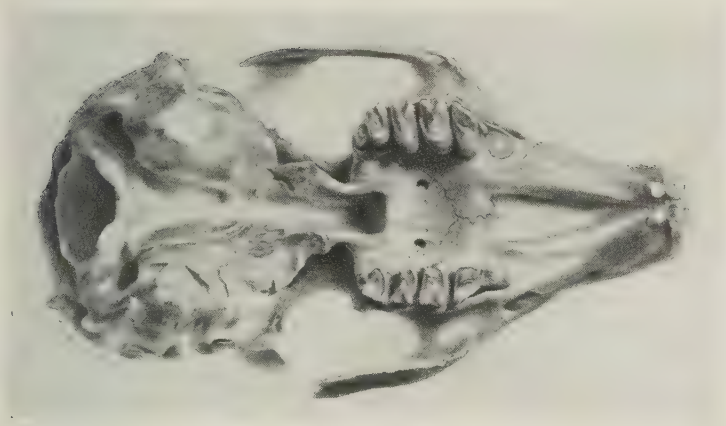

FIG. 1. Lower view of skull

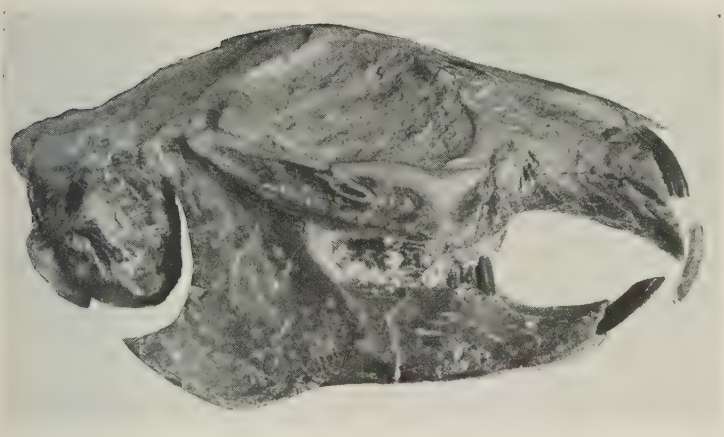

FIG. 2. Right side of skull and mandible

Palaeolagus haydeni, Museum of Paleontology, University of Michigan, Nos. 8942, 14317. × 2

STRATIGRAPHY OF THE SOUTHERN WASATCH MOUNTAINS, UTAH

ARMAND J. EARDLEY

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Thaynes formation: occurrence; character of sediments; thickness; fossils and correlation
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Extrusive rocks
Volcanic breccia: occurrence; petrographic description; age
Volcanic conglomerate: occurrence; character of sediments; origin; age
Intrusive rocks: dikes; sills
Relation and age of extrusive and intrusive rocks
Acknowledgment

Introduction

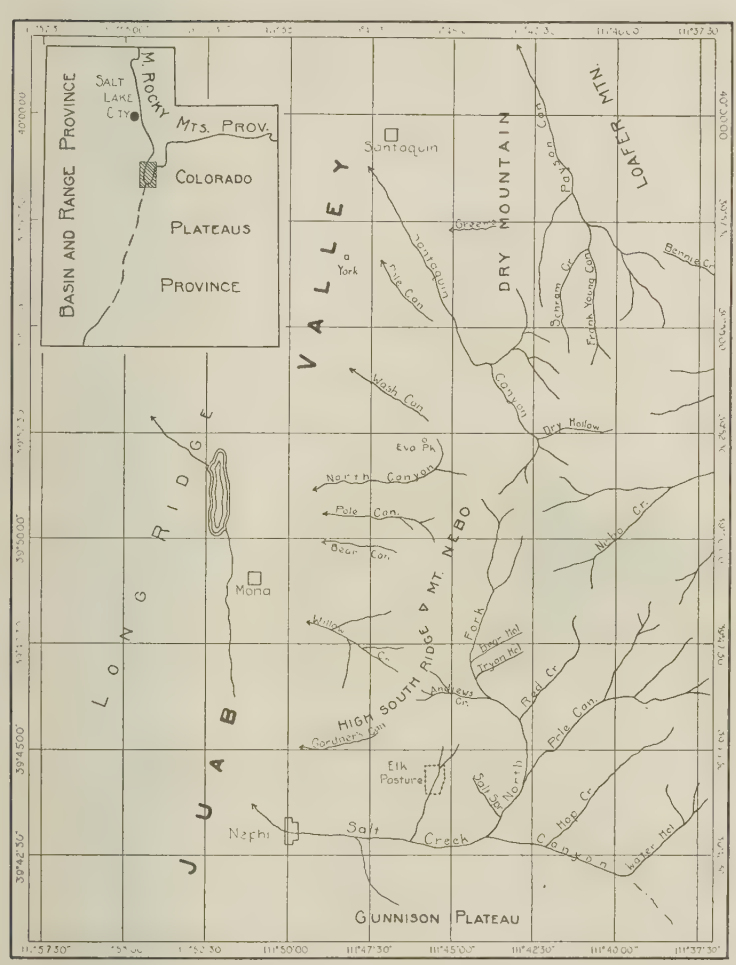
THE southern Wasatch Mountains are situated in the central part of the State of Utah about sixty miles south of Salt Lake City. They lie on the boundary of three physiographic and structural provinces, namely, the Basin and Range, the Middle Rocky Mountains, and the Colorado Plateaus (Map 31); owing to this strategic position they are of much geologic interest. The present paper treats of their stratigraphy. Only a broad outline of the rock sequence can be presented because of insufficient knowledge of detail. Much paleontologic and stratigraphic work still remains to be done.

The Stratigraphic Column

The rocks of the southern Wasatch Mountains range in age from Archean to Recent, and are representative of all the eras and most of the periods of geologic time. Many unconformities and hiatuses, however, attest the fact that the record of past time in this region is only partly complete.

Three unconformities of the first rank exist, namely, the Archean and Algonkian, the Algonkian and Cambrian, and the post-Cretaceous or Laramide. There appears to be no reflection of the Appalachian revolution in the strata of this region.

The Archean, Algonkian, and Cambrian rocks are quite similar to rocks of the same age in surrounding regions; but the rest of the Paleozoic strata does not bear lithologic similarities of correlation value. The Triassic series is probably closely related to rocks of the same age farther north, but the Jurassic rocks compare more closely to the Colorado Plateau lithologic types. Rocks of Cretaceous age do not outcrop in the area of the southern



Map 31. The southern Wasatch Mountains, with insert showing location of the area in the State of Utah

STRATIGRAPHIC COLUMN OF THE SOUTHERN WASATCH MOUNTAINS, UTAH

SYSTEM	SERIES	FORMATION	THICKNESS (feet)	CHARACTER
Quaternary	Recent and Pleistocene	Alluvium	0–3,000	Alluvial fans and valley fill
		~~~Unconformity~~~		
	Pleistocene	Salt Creek fanglomerate	100 ±	Partly cemented, red fanglomerate
		~~~Unconformity~~~		
Tertiary	Pliocene ?	Volcanic rocks	0–800	Volcanic breccia, bedded pyroclastic rocks, sills, and dikes
		~~~Unconformity~~~		
	Lower Eocene	Wasatch conglomerate	0–1,200	Coarse red conglomerate containing a fresh-water ooidal limestone
		~~~Unconformity~~~		
Jurassic	Upper Jurassic	Jurassic shales	3,000 9,000	Gray-drab shale with thin interbedded limestones. Develops red patches upon weathering
		~~~Unconformity~~~		
Triassic ?	Upper Triassic or Lower Jurassic	Ankareh formation	1,400	Deep red, arkosic sandstone
		——— Disconformity ———		
Triassic	Lower Triassic	Thaynes formation	500–1,000	Buff, fine-grained sandstones, and arkoses
	Lower Triassic ?	Woodside formation	200–500	Limestones and red shales
		(?)		
Pennsylvanian	Post-Pottsville Pottsville	Intercalated series	10,000 ±	Great interbedded series of sandstones and limestones. Most sandstones are buff-colored, and many limestones are siliceous
		~~~Unconformity~~~		
Mississippian	Brazer ? Madison	Brazer (?) and Madison	1,600	Dark, usually massive, marine limestones and dolomites. Black shale horizon at top
Cambrian ?	Cambrian or post-Cambrian — pre-Mississippian	Cambrian and undifferentiated limestones and dolomites	2,300 ±	Rather massive, marine limestones and dolomites
Cambrian	Upper (?) Cambrian			
	Lower Middle Cambrian	Ophir Shale	200 300	Olive-drab, micaceous shales, quartzites
	Lower (?) Cambrian	Tintic quartzite	900	Pure silica, pink and gray quartzites
		~~~Unconformity~~~		
Algonkian		Algonkian formation	500–1,000	Dark red quartzites and shales. Shales also maroon and yellow
		~~~Unconformity~~~		
Archean		Archean basal complex	?	Schists, gneisses, granites, and pegmatites

Wasatch Mountains, but are present in neighboring regions as part of the general Mesozoic sequence. The Tertiary Period is represented by rocks of Lower Eocene and Pliocene (?) age. Quaternary rocks cover large areas, and may contain a record of the entire period.

A summarized description of the strata of the southern Wasatch mountains is given in tabular form for convenient reference.

Archean

The lower 2,000 feet of the pre-Cambrian series, the Archean, is composed of granite, gneiss, schist, and pegmatite.

SCHISTS AND GNEISSES

About one third of this Archean basal complex is made up of highly contorted schists and gneisses. The gneisses are much like the schists in mineral composition and may be distinguished from them only by the coarser banding. The schists are well foliated and may be divided into two varieties, mica and hornblende.

Thin sections of the Dry Mountain schists and gneisses correspond closely to those described from Ogden and Farmington canyons, by Zirkel.[1]

The approximate strike of the foliation is N. 4° W.

PEGMATITE

The pegmatite consists of great dikes intruded into the schists and gneisses. It composes about one half of the basal complex and is usually very coarse and consists chiefly of microcline and quartz. This pegmatitic quartz has contributed largely to the conglomerates of the overlying Algonkian and Cambrian quartzites.

GRANITE

The granite is massive and rather fine grained. Hand specimens are pink, and in places have distinct porphyritic tendencies and even pegmatitic facies. Phenocrysts of pink feldspar in the porphyritic granite range in size from 0.5 to 1.5 cm.

[1] Zirkel, Ferdinand, *U. S. Geol. Expl. 40th Par.*, 6 : 22, 25, 26. 1876.

In thin sections the following minerals were found: quartz, 15 to 50 per cent; plagioclase (albite to oligoclase), 40 to 70 per cent; microcline; biotite much altered to chlorite; and accessories (apatite, magnetite, and certain small isotropic grains which may be garnet). No granulation or crushing was observed in thin sections of the various rocks.

In outcrop the granite shows two joint systems, both slightly inclined to the vertical and at right angles to each other.

INTRUSIVE RELATIONS

The schists and gneisses are the oldest of the three rock types, being intruded by both the pegmatite and the granite. No intrusive contacts were found between the pegmatites and the granite, and hence their relative age is not known.

REFERENCE

Loughlin's reconnaissance description of this basal complex characterizes it as "granite-gneiss with schist inclusions." [2] His mineral description is at variance with that given here in only one particular. He determines the plagioclase as sodic andesine, whereas the writer has found it to be gradational between albite and oligoclase.

ALGONKIAN

Loughlin [3] reports 800 to 1,000 feet, by aneroid measurement, of Cambrian quartzite and shale resting "unconformably upon the pre-Cambrian granite" and "gneiss complex." No Algonkian rocks were described; on the ground of this report the statement has often been made that in the Cottonwood district there are over 10,000 feet of Algonkian quartzite, but just fifty miles to the south in the Santaquin region similar rocks are entirely absent. More detailed work has shown that "Loughlin's Cambrian" is composed of Algonkian and Cambrian rocks, which are separated by a pronounced unconformity.

[2] Loughlin, G. F., *Ore Deposits of Utah, U. S. Geol. Surv., Prof. Paper 111*, pp. 1–324. 1920.

[3] *Op. cit.*, p. 324.

Character of sediments. — The Algonkian rocks of Dry Mountain are shales and quartzites. The quartzites are generally dark red, with fine and coarse variations. Most of them are hard and firmly cemented, but occasional sandy beds are encountered. Quartz-pebble conglomerates are frequent within the formation. The pebbles, which are rounded and about one inch in diameter, are composed of white quartz, and are set in a dark red, quartzitic matrix. Fractures break cleanly through the pebbles as if the rock were homogeneous.

The shales are generally dark red also, but occasionally green and bright yellow beds appear. They weather rapidly into transient talus slopes of small angular fragments.

Thickness. — The Algonkian has a thickness of from 500 to 1,000 feet. It is thickest at the abrupt fault termination near Santaquin Canyon, and thinnest about four miles to the north, where it is also terminated by a fault.

Correlation. — No fossils were found except questionable worm borings, which Loughlin mentions.[4] Therefore, correlation of the Algonkian of the Santaquin district with other formations must be based entirely on diastrophism and lithology. This Dry Mountain Algonkian correlates roughly in lithology and exactly in position with the Algonkian in the Cottonwood district and in the American Fork district. In these three localities the Algonkian is composed, in part, of dark red quartzite, is overlain unconformably by characteristic pink Cambrian quartzite, and rests unconformably on a crystalline basal complex, except in the Cottonwood district, where a granite intrusion has destroyed the lower contact.

Archean and Algonkian contact. — The contact of the dark Algonkian quartzites and shales upon the granite is well displayed above the Black Balsam claim on the ridge forming the south side of Green's Canyon. It is sedimentary, with large and small, angular and round, quartz phenoclasts embedded in a light green, and in places dark red, coarse matrix of quartz sand. This basal conglomerate is not more than fifteen feet thick, and is immediately overlain by the dark quartzite. There were no signs of contact

[4] *Ibid.*

metamorphism in any place along the granite contact, thus indicating the granite to be Archean in age.

Cambrian

The Cambrian in the southern Wasatch Mountains consists of three parts: a lower quartzite, a middle shale, and an upper limestone. In this respect it is similar to the Cambrian of the northern and central Wasatch Mountains, of the Oquirrh Mountains, and of the East Tintic Mountains. On the evidence at hand the two lower formations are correlated with the "Tintic quartzite" and the "Ophir shale." The Tintic quartzite in the East Tintic Range was described and named by Loughlin.[5] The name "Ophir Shale" was proposed by B. S. Butler, of the United States Geological Survey, in 1920, with whom Loughlin was associated in the preparation of *Prof. Paper 111, Ore Deposits of Utah.* Loughlin's reconnaissance report of the southern Wasatch Mountains points out the various exposures of the Cambrian. A reference to his map accompanying the report will show these areas; a description of their extent will not be repeated here.

TINTIC QUARTZITE

Character of sediments. — Megascopically the quartzite is of two colors, light gray and light pink. Both varieties are hard and dense, with a decided conchoidal fracture which cuts through the individual quartz grains. In the light gray quartzite rounded quartz grains one-half to three-fourth mm. in diameter are firmly cemented by secondary silica, which fills almost the entire interstitial space. The quartz grains are quite fresh. In the pink variety they are smaller, being only one-tenth to three-tenth mm. in diameter, and are rounded or angular. There is considerable interstitial sericite, but little secondary silica. The cleanness of the silica sand, the roundness of the larger grains, and the angularity of some of the smaller ones suggest that the quartzite consists of ancient beach sands.

The Tintic quartzite is easily recognizable in boulders, and

[5] Lindgren, Waldemar, and Loughlin, G. F., *Geology and Ore Deposits of the Tintic Mining District, Utah, U. S. Geol. Surv., Prof. Paper 107*, p. 23. 1919.

forms a large part of the Wasatch conglomerate and Recent deposits.

Thickness. — The Tintic quartzite has been measured in Green's Canyon on the west slope of Dry Mountain, and presents a thickness of 900 feet. Elsewhere its base is not exposed, and therefore other measurements could not be made.

Correlation. — No fossils are known from the Tintic quartzite. In this section the Ophir shale in which fossils have been found is of upper Lower Cambrian or lower Middle Cambrian age. Therefore, the Tintic quartzite which underlies the Ophir shale must have been formed during some part of Lower Cambrian time.

Algonkian and Cambrian contact. — The Tintic quartzite rests unconformably on the Algonkian. This unconformity is seen at the bottom of the ore shoot on the loading platform of the Union Chief Mine. A conglomerate there exposed contains white quartz pebbles ranging in size from one-half inch to two inches, the majority being about one inch in diameter. The angularity of the contact near the mine is about 15 degrees. The unconformity may best be seen from the top of the ridge between the lower part of Santaquin Canyon and Pole Canyon, Section 30, T. 10 S., R. 2 E. Here the line of the unconformity is about level with the eye, and the truncation of a large series of the Algonkian quartzites and shales by the overlying Cambrian quartzite at an angle of about 25° is visible with textbook clearness. When Dry Mountain is viewed from below, the angularity of this unconformity is greatly decreased by acute perspective, and is not discernible unless its exact position is known.

An extremely coarse phase of the basal conglomerate of the Cambrian is encountered about 1,000 feet north of the mouth of North Canyon, where a prospect hole at an elevation of 6,450 feet follows in along a fault which dips 55° to the west. Just above the prospect hole a basal conglomerate is encountered which is of exceedingly variable composition. The matrix shades between light graywacke and a dark quartzite. The phenoclasts range from small, rounded quartz pebbles to large, angular quartz fragments, and even large, angular blocks of gneiss and schist.

The total thickness of this conglomerate is fifty feet or more. Above it lies the typical lighter Cambrian quartzite, in which an igneous sill is found.

OPHIR SHALE

Character of sediments. — The shale is generally thin-bedded, and of an olive-drab color. It has a very characteristic, micaceous sheen on the parting surfaces. In thin beds it is a true shale, but in beds over one-half inch thick it occurs in the form of a well-cemented sandstone. A thin section of such sandstone shows it to be an aggregate of small, angular, and poorly rounded quartz grains one-tenth to three-tenth mm. in diameter, with a few microcline and plagioclase grains irregularly distributed, and with muscovite shreds along the bedding planes. Muscovite flakes produce the characteristic sheen of the shale. Other light lemon-green grains of the same size as the quartz grains occur prominently and are alteration products of a mineral of rather high relief. They are usually dark between crossed nicols. Neither the alteration product nor the original grains could be determined. A small amount of secondary silica as a cement was observed around the quartz grains, but not enough to make the rock a quartzite.

Thickness. — A good section of the Ophir shale, which is available for study in North Canyon, shows that the contact of the shale with both the underlying quartzite and the overlying limestone is one of gradation between shale and quartzite at the bottom and shale and limestone at the top. The upper and lower limits must, therefore, be arbitrarily established and under this condition the thickness measures approximately 300 feet. On the west face of Dry Mountain it was estimated to be 250 feet.

Fossils and correlation. — In the summer of 1928 fragmental trilobites were found at the Union Chief mine in a rather soft, gray clay-shale, distinctly different from the typical Ophir shale in lithology, but occurring in its upper horizons or in the lower horizons of the limestone into which the shale is transitional. Professor B. F. Howell of Princeton University has kindly identified the following fossils from this formation: *Bathyuriscus sp.; Olenopsis sp.; Ptychoparia sp.* Two brachiopods from the typical

Ophir shale found in Long Range west of York were also identified by him. They are *Obolus sp.* and *Micromitra sp.*

The fauna, especially the trilobites, is similar to that found in the Gordon Shale of Montana and the Ross Lake member of the Ptarmigan formation of British Columbia. This fauna represents either uppermost Lower Cambrian or lowermost Middle Cambrian time, according to Professor Howell.[6]

The Ophir shale has also many tubular structures which, instead of piercing through the layers as worm borings do, repose on them. No detail is preserved, and the meaning of these marks is obscure. Other markings very closely resemble traces of seaweeds. Peculiar mottled surfaces of unknown origin are common.

CAMBRIAN AND UNDIFFERENTIATED LIMESTONES AND DOLOMITES

Above the Ophir shale a thick series of dark, and generally massive, limestone and dolomite beds occur, the lower 2,300 feet of which, so far, have yielded no fossils. Their age is consequently indeterminate and, therefore, the term "undifferentiated" is used in naming them. Certain lithologic peculiarities, such as "ribbon banding" and "oölitic texture," are found in limestones of tentative Cambrian age farther north in the Wasatch Mountains and to the west in the Tintic Mountains. These two characters, which are found in the strata immediately above the Ophir shale also, occur in limestones of the same horizons in the southern Wasatch Mountains and serve as the only basis of correlation. It is, therefore, probable that the lowest 300 feet of the limestones in North Canyon is Cambrian in age.

The rest of the overlying limestones and dolomites may be Cambrian, Ordovician, Silurian, and Devonian, or they may represent all or only part of any one of these. There are no pronounced unconformities within the group. The conclusion may thus be drawn that throughout pre-Carboniferous Paleozoic time the region of the southern Wasatch Mountains was subject to a series of very gentle, alternating emergences and submergences, producing, in the absence of fossils, almost undetectable discon-

[6] Howell, B. F., personal communication.

formities. The region was one of almost exclusive carbonate deposition, which fact indicates that throughout this long span of time no emergence was vigorous enough to cause the deposition of clastic sediments.

The thickness of this Cambrian and undifferentiated series, as measured between the Ophir shale and an arbitrarily established upper boundary where the Carboniferous sediments are thought to begin, is about 2,300 feet.

SECTION OF CAMBRIAN AND UNDIFFERENTIATED BEDS IN NORTH CANYON, T. 11 S., R. 1 E., UTAH

Description of beds	Thickness in feet
Limestone, brecciated	220
Limestone series, noted for sharp jointing. Bedding 6 to 12 inches	200
Dolomite, fine-grained, light gray, fairly massive. Weathers to sandy appearance	100
Dolomite, fine-grained, light gray. Ribbon structure somewhat smaller than lower ribbon horizons	100
Limestone, dark. Bedding 6 to 18 inches. Beginning of great cliff-making horizon	350
Dolomite, dark, wormy	250
Dolomite, white	6
Limestone, dark. Bedding thin	100
Dolomite, dark, wormy	35
Limestone, massive, dark	100
Limestone, ribbon. Bedding 1 inch	25
Limestone, massive, dark	225
Dolomite. Weathers to sandy appearance	3
Limestone, massive, dark	225
Dolomite, dark, small irregular white markings, somewhat wormy. Strike N. 60° E., dip 39° SE.	15
Limestone, ribbon. Bedding 3 to 6 inches	280
Limestone, oölitic. Oölites 2 to 3 mm. in diameter	10
Limestone, characteristic ribbon. Bedding ½ inch to 3 inches, chiefly 1 inch, with irregular gray-buff stringers	50
	2291 ±

Carboniferous

Though there is probably a full sequence of Carboniferous formations in the southern Wasatch Mountains, the compilation of a complete section has not been found possible because of insufficient paleontologic and stratigraphic study. However, Dr. Girty of the United States Geological Survey, who identified the Carboniferous fossils collected by the author, feels certain that the Madison formation, the Pottsville and post-Pottsville horizons, and probably the Brazer formation, are represented in the rocks of the area.

Mississippian

The Mississippian series includes the Madison limestone below, and probably the Brazer formation above. They are both composed almost entirely of limestone and dolomite, except where, toward the top of the Brazer, a considerable amount of black shale appears. The best sections of the Mississippian series are exposed in Santaquin Canyon and North Canyon, but the inability of the writer to find fossils or unconformities in these sections makes the determination of boundaries impossible for the time being. For this reason the Mississippian series has been mapped as one unit.

In the North Canyon and Santaquin Canyon sections the establishment of a lower limit of the Mississippian is purely arbitrary. The series of non-fossiliferous limestones above the Cambrian merges into the Madison without any observed erosional break. Usually the first appearance of small crinoid stems has been taken to represent the boundary. In North Canyon a wind-blown, pure silica, quartzitic sandstone is encountered, together with the first observed crinoid stems. Because of the exceptional occurrence of a sandstone in all the limestone series from Cambrian to Pennsylvanian, it is thought that this sandstone may have some diastrophic import; it has, therefore, been arbitrarily selected, without any fossil evidence, as the lower limit of the Mississippian and as a mappable horizon. It is hoped that some paleontologist will become interested in making a more thorough study of this part of the stratigraphy which is so well exposed in North Canyon.

SECTION OF MISSISSIPPIAN BEDS IN NORTH CANYON, T. 11 S., R. 1 E., UTAH

Description of beds	Thickness in feet
Shale, dark, thin-bedded, with thin limestone lenses. Highly distorted. In Wash Canyon two or three heavy quartzite beds occur	200–300
Limestone, massive, blue. Bedding 1 inch to 4 inches	300–400
Limestone, massive, finely speckled. Cup corals $\frac{3}{4}$ inch in diameter	200
Limestone, dark, massive, dense. Regular beds of chert 1 inch thick at bottom. Chert beds pass upward into chert lentils, which are larger and more irregular toward top	350
Limestone, massive, dark, crinoidal. Small white blotches and markings	15
Shale, black, carbonaceous, calcareous. Dark argillaceous limestone beds intercalated	30
Limestone, dark, fine-grained, conchoidal fracture. Bedding 2 to 6 inches. Small crinoids and cup corals	240
Dolomite, dark, finely crystalline	50
Limestone, gray, massive, small crinoid horizons	120
Quartzite, wind-blown, sandy lenses, pure silica sand	6
Dolomite, gray, with very small crinoid stems and brachiopods. Possibly not Mississippian	30
	1600 +

Madison formation. — Loughlin[7] collected fossils from two horizons, one 400 feet above the other, on Dry Mountain and in Santaquin Canyon. These were declared by Dr. G. H. Girty of the United States Geological Survey to be of Madison age. The upper fossiliferous horizon is a cherty limestone which, because of its singular occurrence, is easily recognizable elsewhere and therefore serves as a convenient stratigraphic marker in other localities.

Collections of Madison fossils were also found, by the writer, in the mouth of Santaquin Canyon, but, because of the complexly faulted rocks in which they occur, their position in the Madison was not determined.

[7] Loughlin, as cited in note 2, p. 325.

The cherty horizon is thought to mark approximately the top of the Madison formation, because of the occurrence of a fossiliferous horizon 400 feet above the chert, the fossils of which Girty has tentatively assigned to the Upper Mississippian. A sharp boundary, however, cannot be located in this 400-foot zone because of the lack of any unconformity to mark a definite break.

Brazer (?) formation. — A series of limestones, with 200 to 300 feet of shale at the top, is included between the known Mississippian and the great Intercalated series of the Pennsylvanian. Loughlin reports a collection of fossils from a horizon 400 feet above the cherty limestones of the Madison, and assigns them tentatively to the Upper Mississippian.

From the low Glenola Valley Hills southwest of Santaquin a single fossil was found by the writer, which Dr. Girty identifies as *Productus brazerianus*. He feels rather confident that it belongs to the Brazer formation which overlies the Madison formation. It is, then, rather definitely known that a post-Madison Mississippian series of limestones is present, and with the occurrence of this Brazer type of fossil, the series is tentatively called "the Brazer formation." It may well be that the Brazer fossil horizon is represented by a hiatus in Santaquin Canyon and North Canyon, and that, therefore, the rocks found in the Glenola Valley Hills must be supplied in the section through North Canyon to make the sequence at all complete. The limestone in the Glenola Valley Hills has facies resembling dense, gray, fresh-water types. Limestones of fresh-water origin are, however, probably not present in the Carboniferous of this region, but a rock of such striking character would have been noticed in the sections through the main ridge of the southern Wasatch, if it did occur. The absence of this limestone, then, strengthens the suspicion that a post-Brazer erosion epoch in Upper Mississippian or early Pennsylvanian time has been responsible for its removal.

The black shales such as are found in North Canyon and Bear Canyon are not present in Santaquin Canyon or in Dry Mountain. Also, the Mississippian series is conspicuously thinner through Dry Mountain than in North Canyon. These additional facts necessitate the conclusion that post-Mississippian emergence and erosion

removed a large amount of rock in increasing proportion to the north, especially in the vicinity of Dry Mountain.

This erosion surface, although not accurately located, was buried by a new lithologic unit of Pottsville age, and is thought to mark the boundary between the Mississippian and the Pennsylvanian.

PENNSYLVANIAN

Intercalated series. — The sedimentary rocks above the Upper Mississippian have a distinctive lithology and have been called by Loughlin [8] the "Intercalated series," a name which is here retained. They are 10,000 feet thick, and consist chiefly of a series of interbedded sandstones and limestones. Very little shale is present. Some of the sandstones are pronouncedly quartzitic, and some of the limestones very siliceous. The Intercalated series forms the whole of Mount Nebo and the high South Ridge. It underlies the Wasatch conglomerate to the east of the Wasatch Mountains from Mount Nebo to Loafer Mountain, and also forms most of the hills south of Santaquin.

Fossils collected at various horizons in the Intercalated series in Santaquin Canyon were identified by Dr. Girty. The lower 7,000 feet contains rather nondescript fossils which he refers to the Pottsville or Lower Pennsylvanian.

Above these lower horizons of the Pennsylvanian a group of faunas occurs which Girty believes are post-Pottsville. In the section in Santaquin Canyon, where a complete sequence is thought to be present, post-Pottsville fossils were found about 9,000 feet above the base of the Intercalated series and 2,000 feet above the last-mentioned Pottsville horizon.

A fauna from the High South Ridge of Mount Nebo is probably also post-Pottsville in age, especially if the evidence from the Gold Hill region applies to the southern Wasatch Mountains. In the Gold Hill region *Fusulina* does not occur in any of the Pottsville faunas and, therefore, the occurrence of this fossil is thought to indicate the presence of some post-Pottsville horizon.

Other post-Pottsville faunas were found on the south slope of

[8] Loughlin, as cited in note 2, p. 325.

Loafer Mountain above the mouth of Schram Creek and on the east slope of Dry Mountain above Maple Dell.

In Gardner's Canyon *Fusulina* are abundant in the limestones which overlie the Jurassic shales.

At the head of Santaquin Canyon in Dry Hollow, above the post-Pottsville horizons, a fauna is encountered which, according to Girty's incomplete fossil evidence from Gold Hill and the Oquirrh Mountains, is correlated with the Pottsville horizon of the Gold Hill section. This confirms the writer's suspicion that a repetition of the strata, probably by faulting, has occurred here.

As already mentioned, Dr. Girty finds that the Carboniferous faunas of the southern Wasatch Mountains are represented in the Gold Hill and Oquirrh Mountain sections. It would, therefore, appear that the Carboniferous strata of the southern Wasatch Mountains bear close relationship to the rocks of equivalent age to the west and northwest. To the north, in the central and northern Wasatch Mountains, Carboniferous rocks of entirely different lithologic aspects occur. It is concluded, then, that the Carboniferous rocks of the southern Wasatch Mountains are to be correlated with those of Gold Hill and the Oquirrh Mountains, rather than with those to the north in the Wasatch Mountains.

Relation of Pennsylvanian to Triassic

The transition from the Carboniferous to the Triassic may be seen in the North Fork of Salt Creek Canyon at Camp Dadandson. From a distance red strata appear sparingly interbedded with the upper members of the Intercalated series, but become more and more numerous, until they finally form the entire rock series. Since no decided lithologic change or any evidence of an angular unconformity was noted, the contact between the Intercalated series and the Woodside of the Triassic is purely an arbitrary one, and leaves several hundred feet of strata, in which a few red beds occur, assigned to the Intercalated series.

No definite break between the Carboniferous and Triassic has been found to the north, either at Park City [9] or in south-

[9] Boutwell, J. M., *Geology and Ore Deposits of the Park City Mining District, Utah, U. S. Geol. Surv., Prof. Paper 77*, p. 46, Pl. V. 1912.

eastern Idaho,[10] although in the Wasatch front east of Salt Lake City Schneider [11] recognizes "evidence of a disconformity." The nature of this disconformity is not stated, probably because of the brevity of the paper.

Because of lack of fossils, especially in the red beds, it is not known whether rocks of Permian age are present. From physical evidence it would appear that possibly a complete transition is present; but from the previously noted difficulty in finding fossils or erosional breaks, it must be concluded that that part of the geologic history represented in the transition from Pennsylvanian to Triassic time remains an unsolved problem in the southern Wasatch Mountains.

Triassic

OCCURRENCE

The Triassic series of rocks follows down the eastern flanks of the Wasatch Mountains from the Park City district to the Nebo district. At Thistle Junction the Triassic beds, which dip steeply to the east, begin to swing westward. They soon disappear under the Tertiary cover in the neighborhood of Bennie Creek, only to reappear again in the North Fork of Salt Creek Canyon, where erosion has cut through the flat-lying Tertiary rocks into the upturned Mesozoic strata beneath. Here the beds strike northeast and dip from vertical to 45° northwest. The area mapped does not include the Thistle Junction exposure, but only the ones in Salt Creek Canyon.

WOODSIDE (?) FORMATION

Character of sediments. — The base of the Triassic rocks in the North Fork of Salt Creek Canyon consists of dull red sandstones and shales interbedded with thin, light gray and buff-colored shales and sandstones. Limestone beds 2 to 4 feet in thickness, apparently of marine origin, are also present. The

[10] Mansfield, G. R., *Geography, Geology, and Mineral Resources of Part of Southeastern Idaho, U. S. Geol. Surv., Prof. Paper 152*, p. 85. 1927.

[11] Schneider, Hyrum, "A Discussion of Certain Geologic Features of the Wasatch Mountains," *Journ. Geol.*, Vol. 33 (1925), No. 1.

bottom of Bear Hollow marks the lower limit of this formation. It may also be seen as a red band around the steep slope of the high south ridge of Mount Nebo, some 500 feet above the junction with the more gentle relief of the north slopes of Salt Creek Canyon.

Thickness. — This group of beds is only 150 to 200 feet thick. The lower limit is purely arbitrary, as previously explained under the caption "Relation of Pennsylvanian to Triassic," and could without difficulty be shifted to lower horizons, which would thus increase the thickness.

Correlation. — This series of red beds with intercalated marine limestones passes conformably into a light gray and buff-colored series called "the Thaynes formation." The Thaynes bears fossils corresponding to those identified from the Thaynes of the Park City district, which is Triassic in age. Conformably underlying the Thaynes in the Park City district is a homogeneous dark red shale 1,100 feet thick. So far as known, this bears no fossils, and is called Triassic only on the ground that it resembles certain beds in the known Triassic Thaynes. This dark red shale group has been called by Boutwell [12] "the Woodside Shale." Although the thickness of the red beds at the base of the Triassic in Salt Creek Canyon is only a sixth of that in Park City, the two occupy similar stratigraphic positions and are of the same color. On these grounds they will be tentatively correlated as the same formation. Schneider mentions the Woodside on the Wasatch front east of Salt Lake City as more sandy and more calcareous than in the Park City district, but not so deep red.[13] The thickness is not given, but the writer's own examination of the ground would estimate it as only a few hundred feet. Thus the Woodside east of Salt Lake City corresponds more closely to the Woodside of Salt Creek than does the Park City. It may be that this Woodside formation in Salt Creek is considerably reduced in thickness by being involved in the Nebo overthrust, of which not all details have yet been fully worked out.

At the head of Santaquin Canyon, a short distance up Dry Hollow, a red sandstone begins with typical Ankareh color and

[12] Boutwell, as cited in note 9, p. 52.
[13] Schneider, as cited in note 11, p. 38.

laminations, but apparently in stratigraphic position with the Woodside. Major faulting has probably occurred in this vicinity, as previously mentioned, and the significance of this red sandstone at the top of the Intercalated series in Santaquin Canyon is, therefore, not known.

THAYNES FORMATION

Occurrence. — The Thaynes formation occurs stratigraphically above the Woodside (?) formation, but in outcrop below it because of the overturned structure. It crosses the North Fork of Salt Creek Canyon between Bear Hollow and Cow Hollow, but is poorly exposed. It transects the upper part of Andrew's Canyon, where it is most accessible, and a few fossils may be found in the float and weathered outcrop. It comprises roughly the lower 500 feet of the high South Ridge below the Woodside, and here finally wedges out toward the west owing to implication in the Nebo overthrust.

Character of sediments. — The Thaynes formation consists of a series of fine buff and gray sandstones, with some distinctly limy beds intercalated. The sandstones are both thinly and thickly bedded, and some have a good development of laminations. Thin sections show the sandstone to be composed chiefly of an aggregate of quartz and muscovite grains, with maximum diameter of one-twentieth mm. The quartz grains form the greater part of the rock. The rock effervesces freely when tested with hydrochloric acid.

Thickness. — Because of varying dips and acute truncation by the Nebo overthrust, the thickness can be only estimated. It ranges from 500 to approximately 1,000 feet.

Fossils and correlation. — The following fossils found in this formation were identified by Dr. Girty: *Aviculipecten sp.; Pseudomonotis? sp.; Bakewellia? sp.; Myacites inconspicuus?*. These fossils, though few, correlate with those of the Thaynes[14] of the Park City district. In lithology the two formations are somewhat alike. Therefore, in view of the stratigraphic position, the lithological similarity, and the fossil evidence, this group of

[14] Boutwell, as cited in note 9, p. 55.

fine, buff sandstones of Salt Creek and Mount Nebo is called "the Thaynes formation."

Boutwell, in his first studies of the Park City district, found the fossil content of the Thaynes to agree with that of the "Permo-Carboniferous beds" of the Fortieth Parallel Survey, but his later work states it to be faunally related to Peale's "Mekoceras beds" [15] of southeastern Idaho, which had been referred by C. A. White [16] to the Triassic, although the Park City district does not contain ammonites. Further studies of the cephalopod genera by Hyatt and Smith [17] showed that the fauna of Idaho is intimately related to the Lower Triassic faunas of India and eastern Siberia, and that it contains species which may even be identical with those from Asia. The Thaynes is, therefore, assigned to the Lower Triassic. No ammonites were revealed in the Salt Creek Triassic, but it is held to be of the same age as the Park City Triassic, whose tripartite lithologic and stratigraphic division it so closely resembles.

Professor A. A. L. Mathews [18] has published an article on a new ammonite fauna of the Thaynes formation which he found east of Salt Lake City. In this paper he splits the previously recognized Thaynes into two groups, and names the lower one "the Pinecrest formation," from Pinecrest Ridge in Emigration Canyon, the upper group retaining the name "Thaynes formation." Later he applies the name "Emigration" to the upper formation instead of "Thaynes," but still uses "Thaynes" as a group name which includes both the Pinecrest and Emigration formations.[19] The Pinecrest formation is reported as lower than Boutwell's Park City Thaynes, and is not represented there in the type locality. In personal conversation Professor Mathews has

[15] Peale, A. C., "Report of the Green River Division," *U. S. Geol. and Geog. Surv. Terr.*, Eleventh Ann. Rep., pp. 621–629. 1879.

[16] White, C. A., "Triassic Fossils of Southeastern Idaho. Contributions to Invertebrate Paleontology," No. 5, *U. S. Geol. and Geog. Surv. Terr.*, Twelfth Ann. Rep., pp. 105–118. 1880.

[17] Hyatt, Alpheus, and Smith, J. P., *The Triassic Cephalopod Genera of America, U. S. Geol. Surv., Prof. Paper 40*, pp. 17–19. 1905.

[18] Mathews, Asa A. L., "The Lower Triassic Cephalopod Fauna of the Fort Douglas Area, Utah," *Walker Museum Memoirs*, Vol. 1, No. 1. 1929.

[19] Mathews, Asa A. L., "Mesozoic Stratigraphy of the Central Wasatch Mountains," *Oberlin College Lab. Bull.*, New Ser., No. 1, p. 4. 1931.

stated that he believes that the Thaynes as represented in Salt Creek Canyon is equivalent to the upper division or Emigration formation and does not include his Pinecrest formation.

ANKAREH FORMATION

Occurrence. — The Ankareh in Salt Creek Canyon emerges from under the Tertiary cover just below Tryan Hollow, dipping 40° to 60° NW., and strikes southwest diagonally across the North Fork to Andrew's Canyon, where it crosses at the head of the road and swings into Mahogany Knoll. Continuing west, it thins rapidly until at the knoll formed of Wasatch conglomerate, about one mile west of the elk pasture, it is entirely lacking. From there west to the Wasatch front the Intercalated series is in contact with the Jurassic shales, with only occasional irregular red rocks observable. The entire Triassic system of some 2,500 feet in thickness has disappeared here at the base of the high, overturned South Ridge of Mount Nebo, which is within four miles. The Nebo overthrust is undoubtedly the cause.

In the Ankareh formation in Andrew's Canyon is an old quarry from which the red sandstone has been extracted for use as a building stone by the early settlers. It breaks evenly along the bedding and at right angles across the bedding, so that it is easily worked.

Character of sediments. — In the Park City district, where the type section of the Ankareh occurs, the major part of the formation consists of red shales, but these grade through considerable thicknesses into sandy facies. A number of well-marked, coarse, gray sandstone beds are also present, together with intercalated blue-gray limestones. In Salt Creek Canyon a solid red massive sandstone is the dominant rock type. Purple, light pink, and creamy shades lend variation, however, to the dominant red. A fifty-foot shale member is also noted near the lower part of the formation, which varies in color from red to light green. Limestone float suggests the presence of limestone layers, as in the Park City district, but none were found in place.

A microscopic examination of a laminated specimen of red Ankareh sandstone, taken from the quarry at the head of the road

in Andrew's Canyon, shows that the quartz grains range from one-tenth to one-fifth mm. in size, are mostly angular, and comprise about 50 per cent of the slide. Andesine-plagioclase grains are plentiful and little weathered. The second most abundant constituent is an alteration product consisting of sericite and probably calcite. The sericite may have come from a more sodic feldspar. The calcite is probably secondary. The rock effervesces freely when tested with hydrochloric acid. Some muscovite shreds and a zircon grain were observed. Silica in small amounts around the quartz grains is common, but the chief cement is dark brown hematite. It is interstitial, but bunchy and not consistently distributed between all the grains or in coatings around the sand particles. A thin section of the Ankareh sandstone east of Salt Lake City showed the hematite to be concentric around each sand grain, however. If the single slide studied is at all characteristic of the formation as a whole in Salt Creek, the rock is undoubtedly an arkose. Although the writer is not aware that any rocks of this nature, either in Park City or east of Salt Lake City, have been recognized, this occurrence is not unusual, because the Triassic sandstones of the Colorado Plateau are in places quite arkosic.

Thickness. — The upper beds of the Ankareh in the North Fork of Salt Creek Canyon are thought to be absent because of concealment by the Nebo overthrust. The section as exposed in Salt Creek Canyon measures 1,500 feet in thickness; but the total thickness is probably greater.

Correlation. — No fossils were found in any part of this red series of the Triassic. The writer's acquaintance with the lithologic characteristics of the Ankareh formation east of Salt Lake City makes him feel positive that these upper red beds in Salt Creek Canyon are also Ankareh. The conspicuous red Ankareh can be traced almost continuously down the east flank of the Wasatch Range from the type locality at Park City to the Nebo district. This fact, together with the similarity in stratigraphic position and lithology, is the basis for correlation with the Ankareh of the Park City district and the Ankareh of the Wasatch front east of Salt Lake City.

Jurassic

Occurrence. — Strata of Jurassic age are found on both sides of Salt Creek Canyon, down the west side of the Gunnison Plateau as far as the town of Fayette, and in southern Sanpete Valley south of Mayfield. Their total thickness is very great, but because of the extreme contortion and incomplete exposures of the beds the exact thickness cannot be stated. It probably is represented by a figure between 4,000 and 11,000 feet.

Character of sediments. — A gray-drab shale is without doubt the thickest formation in the Jurassic series. It may be readily recognized by the subdued, bad-land terrane into which it erodes and by the red or pink patches of coloring scattered promiscuously over the surface (see Pl. XXVII).

An unusual rock type in the Jurassic series is a travertine, probably of spring origin. If it were not shattered so extensively by joints it would probably make a good interior-decoration stone. Because of its vivid, wavy, red and white banding it is called commercially "jazz marble." Specimens are shown in Plate XXVIII, Figure 2.

Thickness. — The Jurassic section is represented in the table at the top of the opposite page.

Fossils and correlation. — In the lowest observed member of the Jurassic series, the oölitic limestone, the following fossils were found by the writer and identified by J. B. Reeside, Jr.: *Pentacrinus asteriscus* Meek and Hayden and *Ostrea strigilecula ?* White.

In the thick shale formation the following fossils were identified, again by Dr. Reeside: *Camptonectes stygius* White, *Camptonectes sp.*, *Pentacrinus asteriscus* Meek and Hayden, *Ostrea strigilecula ?* White.

These fossils are upper Jurassic, according to Dr. Reeside, and possibly equivalent to the Sundance formation of Wyoming. The Jurassic shales as found in Salt Creek Canyon have been noted by Gilluly and Reeside [20] along the west front of the Wasatch

[20] Gilluly, James, and Reeside, J. B., Jr., *Sedimentary Rocks of the San Rafael Swell and Some Adjacent Areas in Eastern Utah, U. S. Geol. Surv., Prof. Paper 150–D*, p. 73. 1928.

SECTION OF JURASSIC BEDS IN SALT CREEK CANYON, UTAH

Description of bed	Thickness in feet
Shale, drab, calcareous, arenaceous, generally thin-bedded. Occasional thin, lenticular limestone and sandstone beds intercalated. Patches of red coloring frequent, but do not follow any one bed. Highly contorted. Weathers into soft landscape. Salt and gypsum lenses	3,000–10,000
Travertine, wavy alternating bands of white and red calcium carbonate. Red bands highly impregnated with hematite. White bands are columnar aggregates of calcite crystals. Some silica replacement	100 +
Sandstone, red to drab, thin-bedded, in part laminated	10
Gypsum, stubby lens in North Fork of Salt Creek, coarsely crystalline (crystals $\frac{1}{10}$ inch to 2 inches in length). Considerable earthy material admixed	250–300
Travertine, same as travertine above	400 ±
Shale, same as shale above	400
Limestone, rather massive, creamy brown. May be somewhat siliceous	30
Limestone, drab with pink tint, oölitic, fossiliferous (Pl. XXVIII, Fig. 1)	20
PLANE OF OVERTHRUST	4,210–11,260

Plateau and correlated with the Carmel formation of the San Rafael Swell and the Henry Mountains.

Lithologically, these shales have no counterpart either north in the Wasatch Mountains or southwest in the Colorado Plateau. They do, however, bear a closer resemblance to the Entrada and Curtis formations of the Swell than to the Twin Creek limestones of the central Wasatch. For correlation of Triassic and Jurassic sections in the Wasatch Mountains see Figure 13, page 332.

Triassic and Jurassic contact. — The Ankareh sandstone is separated from the Jurassic oölitic limestone by an unconformable contact which may be interpreted as either an erosional unconformity or an overthrust fault. This question will be discussed in detail in a future paper on the structure of the southern Wasatch Mountains, and therefore will not be introduced here. The conclusion reached, however, is that the contact is an overthrust

fault in which neither Upper Triassic beds nor the lower beds of the Jurassic series are represented, owing to concealment by the thrusting.

Gypsum. — The Wheeler Survey recognized the Salt Creek shales as Jurassic,[21] and in the report stated that "The Jurassic

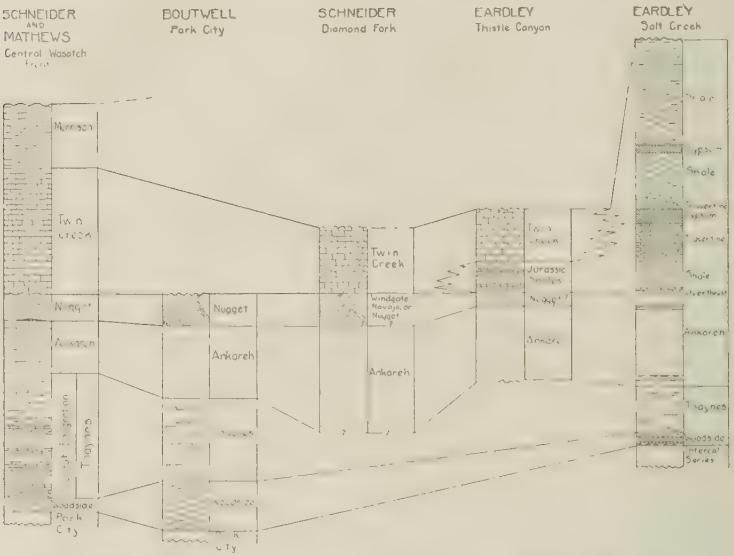


Fig. 13. Triassic-Jurassic columnar sections of Wasatch Mountains. 1 inch = 1,000 feet

rocks are everywhere found to be gypsiferous, and in some places good workable beds of gypsum are seen. One of these beds occurs at Salt Creek near Nephi.[22]

In 1904 a report of the gypsum deposits of the United States was published by the United States Geological Survey, in which the Nephi deposits were described by J. M. Boutwell.[23] His visit

[21] *U. S. Geog. and Geol. Surv. W. 100th Mer.*, atlas sheets 50 and 59.

[22] Howell, E. E., *U. S. Geog. and Geol. Surv. W. 100th Mer.*, 3 : 264.

[23] Boutwell, J. M., *Gypsum Deposits of the United States, U. S. Geol. Surv., Bull. 223*, pp. 102–109. 1904.

was made in the wintertime when snow concealed the outcrops, but nevertheless, his conclusions as to origin agree with those of the writer. He says: [24]

> Although the study of the region was too hasty to obtain sufficient data for a complete explanation of the deposit, general observations, together with facts brought out by analyses, afford accordant evidence for an opinion. The bedded structure of the gypsum, the agreement of this bedding with that of the country rock, the interbedding of wall rock and gypsum, and the occurrence in the same series in this neighborhood of rock salt, common salt and gypsum of various degrees of impurity tend to indicate a sedimentary origin. The presence of about 17 per cent calcium carbonate, one-half of one per cent of magnesium carbonate, and minor amounts of potassium and sodium salts afford additional basis for the belief that this gypsum is the product of deposition from surface water bodies, such as inland lakes, lagoons, and bayous.

This gypsum deposit has since been mined out, and proves to be a bunchy-thick lens without much continuation between the bedding planes. Gypsum is now being mined about two miles to the north on the spur between Red Canyon and Quaking Asp Canyon. This deposit likewise cannot be traced for any distance along the bedding. Another outcrop in Gardner's Canyon is also terminated rather abruptly at both ends of the outcrop. Other gypsum showings have been discovered and claimed farther up Salt Creek Canyon, all of which are only of short surface extent. Boutwell's reasons for determining the genesis of the gypsum are sufficient. The only addition to be made here is one explaining the thick lenticular nature of the deposits. The shales show intense compressional distortion. It is thought likely that under such conditions thin gypsum beds have yielded to variations of pressure by flowage, thickening where relief occurred, and thinning where pressure concentrated. The pressure and subsequent folding of the Jurassic shales came from the competent Paleozoic rocks in the Nebo overthrust.

Salt. — Two rock-salt pits and a salt spring are located in the North Fork of Salt Creek Canyon. One salt pit is found just to the north of the mouth of Red Creek. Another is located on the west side of North Fork about half a mile up from the main Salt Creek Canyon. Impure rock salt has been mined for cattle. In both places a red earthy material is associated with the salt.

[24] Boutwell, *op. cit.*, p. 109.

This may be due to the fact that the surface outcrop is badly weathered and that quarrying has not proceeded far enough to expose the true nature of the salt, or, on the other hand, to the secondary deposition of salt at the surface by evaporation of salt water issuing through seeps or springs. The fact that the salt is associated with detrital material of the travertine country rock in one pit and with volcanic-ash country rock in the other seems to justify the conclusion that the salt is secondary. If this idea of origin is true, then there would be no hope of finding more solid and massive beds of salt with greater development of the pits. It is inferred that the salt comes from the Jurassic shales, where it existed as interbedded deposits, perhaps associated with the gypsum. The salt spring about one-half mile up the gulch opposite Red Creek flows from the Jurassic shales just above the point where the gypsum deposit dies out. In Sanpete Valley great beds of salt are interbedded in Jurassic sediments. From these known sources and from the irregular occurrences of salt near the surface in younger deposits it is concluded that all the salt in Salt Creek comes from the Jurassic shales.

The salt water emerges saturated and, upon slight evaporation, deposits crusts of salt along either side of its course. The salt brine is piped to an evaporation plant where a very high grade of salt is obtained. It was reported over 99 per cent NaCl. It settles as flakes on the bottom of large evaporation pans, and is claimed by the management of the plant to be of particular commercial value in the curing of meats, the making of cheese and butter, etc.

Tertiary

Wasatch conglomerate

Occurrence. — The Wasatch conglomerate is confined chiefly to the east slopes of the high, sharp, single ridge of the southern Wasatch Mountains. It also occurs east and west of York in T. 10 S., R. 1 E. It is separated from the underlying rocks of Paleozoic and Mesozoic age by a pronounced unconformity. In Salt Creek Canyon the pre-Tertiary beds have been overturned, truncated, and covered by this Wasatch conglomerate.

It has a maximum thickness of about 1,200 feet, measured in the area between Red Creek and Bear Hollow, but has suffered erosion intermittently from Eocene time to the present, so that it was once much thicker.

Character of sediments. — Loughlin's description of this conglomerate holds for most places, though in one or two localities varying types are found. He says: [25]

> The conglomerate consists of pebbles, and in places even small boulders, mainly of quartzite, limestone and black chert in a soft red sandy matrix. The quartzite pebbles include both Cambrian and upper Mississippian (Intercalated series) types, the Cambrian greatly predominating. The limestone pebbles include the shaly Cambrian types, dolomitic types of lower Mississippian and probably earlier age, and the coarse grained gray limestone of upper Mississippian age. This variety of pebbles proves that almost the entire Paleozoic section was exposed to erosion while the conglomerate was forming. There is no evidence, however, that the pre-Cambrian rocks were exposed to erosion at this time. Owing to the tendency of the red matrix to rapid weathering, many outcrops of the conglomerate are reduced to an aggregate of loose pebbles and boulders in a soft red soil.

Dark purple quartzite boulders are quite numerous, and these come from the Algonkian which, as previously explained, Loughlin has grouped with the Cambrian. Therefore, the Algonkian rocks were also exposed to erosion during the deposition of the conglomerate.

About one mile up the North Fork of Salt Creek the conglomerate does not have the characteristic red appearance, but is more yellow and gray, and is not composed of rounded pebbles and boulders, but of very angular phenoclasts. It resembles a skree or fanglomerate more than a basal conglomerate in this particular place. The difference in color is partly due to the difference in kind of phenoclasts, chiefly sandstones and limestones of the Intercalated series. Very little Cambrian material is here present.

In Payson Canyon, west of Maple Dell, is a small ridge, the lower half of which is Tertiary conglomerate. Here large fossiliferous limestone blocks, some over six feet long, are firmly embedded. They come from the Intercalated series.

The dip of the conglomerate immediately east of the southern

[25] Loughlin, as cited in note 2, p. 326.

Wasatch Mountains is mainly initial, and has been changed but little by deformation since deposition, although in two localities dips up to 40° have been recorded. This conclusion is verified by the horizontal position of a bed of limestone occurring within the conglomerate in the immediate vicinity of the high dips.

Source of sediments. — The contact of the Wasatch conglomerate with the underlying rocks is sedimentary. Therefore, in solving the problem of the source of the material it is safe to assume present relationships as existent at the time of deposition. The conglomerate becomes finer to the east, eventually changing to shales and limestones, thus indicating a western origin of the sediments. They begin on the east slopes of the southern Wasatch Mountains in alluvial-fan structure. This, then, must have been the western margin of the basin into which they were deposited. The present high ridge of the southern Wasatch Mountains was much higher than it is now, and also the Basin and Range country to the west stood 5,000 or 6,000 feet higher before the block-faulting began. The high ridge and the area to the west is therefore postulated to have supplied the material which composes the Wasatch conglomerate.[26]

Age. — Within the Wasatch conglomerate is a fresh-water limestone bed of interesting character which the writer has described in a separate publication.[27] It has yielded gastropod fossils determined as lower Eocene in age, probably equivalent to the Knight formation of southwestern Wyoming. The paper on this limestone formation discusses the questions of age and name and therefore repetition is not necessary here.

Quaternary (*Pleistocene ?*)

Salt Creek fanglomerate

Occurrence. — A thin formation overlying the volcanic, water-laid deposits and the Jurassic shales in Salt Creek Canyon will here be called "the Salt Creek fanglomerate." From the main

[26] Eardley, A. J., "A Limestone Chiefly of Algal Origin in the Wasatch Conglomerate, Southern Wasatch Mountains, Utah," *Pap. Mich. Acad. Sci., Arts and Letters*, 16 (1931) : 406, Fig. 14.

[27] *Op. cit.*, pp. 399–414.

highway it may be seen as a red capping on the west side of the mouth of Foots Canyon and over the castellated volcanic ash at the junction of the North Fork and the main canyon. Without close inspection this latter occurrence might be mistaken for Wasatch conglomerate. The beds show a low dip away from the high South Ridge. This is most probably initial, since no deformation has disturbed the beds since deposition.

Character of sediments. — The Salt Creek formation is composed of a mixture of large and small angular rock fragments, rudely sorted, with a matrix of red earthy material. Cementation is usually poor. Stratification is rough and channeled. In most places the formation is a fanglomerate. At the head of Foots Canyon, above the elk pasture, it contains no Cambrian quartzite or older Paleozoic limestones. It is composed entirely of material from the Intercalated series, the Triassic sandstones, and the Jurassic shales and limestones. In this particular location, then, it is demonstrated to be alluvial-fan material coming from the high South Ridge of Mount Nebo immediately to the north.

Age. — The Salt Creek fanglomerate overlies the volcanic deposits unconformably. The former is, therefore, decidedly younger than the latter, which in turn is younger than the Eocene Wasatch conglomerate. No fossils have been found in either the fanglomerate or the volcanic deposits by which a definite age of one or both could be determined, although separation from Eocene deposits by two unconformities suggests late Tertiary or Pleistocene age for the fanglomerate.

The physiographic setting, however, lends some aid to the solution of the problem. The fanglomerate rests on an old, mature, valley floor which has since been incised to a depth of about two hundred feet where the fanglomerate occurs. The rejuvenation is due to block-faulting of Basin and Range age which has lowered the base of deposition of Salt Creek. If this old valley upon which the fanglomerate lies can be shown to be of prefaulting age, then the fanglomerate must also be of prefaulting age and, therefore, probably Pliocene. But there exists certain evidence which suggests that the older valley was eroded during an interim of faulting, in which case the fanglomerate would correspond

in age to an epoch of time in the Pleistocene. The problem is not yet solved and must await further physiographic study.

RECENT ALLUVIUM

Fault scarps and subaërial deposition have given rise to topographic forms typical of the Great Basin. All along the west front of Mount Nebo, from York to Nephi, large and symmetrical alluvial fans coalesce, forming a piedmont slope. The piedmont grades out into the flat bottom of Juab Valley, where the finer sediments have been deposited. Another well-developed piedmont is found between the upper part of Salt Creek Canyon and the north end of the Gunnison Plateau. The piedmont on the west front of Dry Mountain, east of Santaquin, reflects the influence of Lake Bonneville. Deltaic deposits, reworked to some extent by alongshore currents, here supplant the fans of Juab Valley.

G. K. Gilbert mapped Lake Bonneville at its uppermost level, the Bonneville level, as extending past York into Juab Valley. This conclusion is warranted by the presence of a few small terraces on the west side of the valley at the base of the east slope of Long Ridge. But the body of water was small and probably short-lived, because of its almost complete isolation from the main body of water by a shallow pass at York. The piedmont along the west front of Nebo shows no effects of the presence of a lake, and it marks a striking change from the deltaic and terraced piedmonts northward along the Wasatch.

Some small, low bars southwest of Santaquin indicate that the currents which carried the sand and gravel came from the northeast.

The terraces and bars date from the Bonneville level of old Lake Bonneville. This is the oldest of the recorded stages of the lake.

Alluvial fans are building at the present time, but, like the valley-floor deposits, are older at the greater depths, so that those deposits immediately overlying the lowest areas of the hard rock floor of the down-faulted block date back to the initiation of the Basin and Range faulting of this section.

Igneous Rocks

extrusive rocks

Extrusive rocks in the form of volcanic breccia and water-laid volcanic ejectamenta cover considerable portions of the district.

Volcanic breccia

Occurrence. — The largest area of volcanic breccia occurs in Payson Canyon flanking the east slope of Dry Mountain, where it covers roughly four square miles and has a maximum thickness of about eight hundred feet. This deposit is not shown on the geologic map of the state of Utah. On the west side of Dry Mountain, at the mouth of Santaquin Canyon and in the hills both east and west of York, are large amounts of felsite-porphyry boulders of all sizes. Loughlin views these aggregates of loose cobbles as the result of rapid weathering of the soft-tuff matrix of a volcanic breccia. It must not be erroneously inferred, however, that the presence of these volcanic cobbles indicates the occurrence of the original breccia beneath. In most places boulders of Cambrian and Algonkian quartzite are mixed with the volcanic boulders. This condition could not arise if the latter represent a reduction of the breccia to an aggregate of loose cobbles. Volcanic boulders, which are seen in road cuts and washes, form part of the alluvium. They may be residual to this alluvium. Over other small areas the surface is a mass of volcanic cobbles to the exclusion of everything else. In such places it is quite likely that the original breccia has existed or still exists beneath. Most of the boulders are rounded, but the exact significance of this observation is not known. The rounding may be due to exfoliation, or to stream wear, so that boulders of a residual deposit may be rounded as well as those found in the alluvium.

In Pole Canyon, south of Santaquin Canyon, a small patch of volcanic breccia, which is the same as the Payson Canyon breccia, was mapped. This small remnant is probably the last of a once much more extensive deposit; the boulders and fragments which now strew certain parts of the low hills around confirm this assumption.

In the upper basin of North Canyon another small patch of breccia is still intact, and indicates the former existence of the deposit, at least for this distance south of Payson Canyon.

Petrographic description. — Loughlin briefly describes the type of volcanic rock found around York [28] and finds two varieties, namely, "augite andesite" and "hornblende-augite andesite." Thin sections from all the eruptive volcanic rocks of the area studied by the writer agree with Loughlin's determination. It should be pointed out, in addition, that these rocks are porphyritic, the phenocrysts being largely labradorite.

Age. — The volcanic breccia is later than the Wasatch conglomerate because it rests unconformably upon it. Its relation to the Basin and Range faulting is very difficult to determine directly, but by correlation with a deposit of clastic volcanic rock of known age it is thought to predate the faulting. This evidence will be given later.

VOLCANIC CONGLOMERATE

Occurrence. — In the Salt Creek Canyon area another deposit of volcanic material exists, which in surface extent is about as large as that of the Payson Canyon breccia. In the fork of Salt Creek that drains the eastern slopes of Mount Nebo this deposit extends from Red Creek to the main Salt Creek Canyon.

Character of sediments. — Unlike the andesite breccia of Payson Canyon, the volcanic deposit here consists of andesite pebbles and boulders of all sizes from one-half inch up to two feet in diameter, embedded in a roughly stratified, water-laid matrix of volcanic ash. In Pole Canyon this deposit of igneous material consists of two parts: an upper, dark horizon, with stratification, channeling, and thick lenses, all extremely coarse, and a lighter and lower division, in which poor but better sorting is evident (see Pl. XXIX).

The Wheeler Survey observed this volcanic material along the road in Salt Creek Canyon, and drew on their maps a considerable area of "extrusive igneous rock." This same area has been transcribed upon the geologic map of the State of Utah

[28] Loughlin, as cited in note 2, pp. 326–327.

which accompanies *Professional Paper 111*. The deposit is, in reality, only about one tenth as large as there mapped and, strikingly, is roughly limited to the present main drainage channels of Salt Creek. From the nature of this volcanic material and its position in reference to the Wasatch conglomerate and the present drainage lines, it is interpreted as being valley fill in old channels in the Wasatch conglomerate. The old drainage lines followed somewhat the same courses as now. The streams in these courses suddenly became torrential and overloaded with loose volcanic material. Deposition with rough stratification accompanied this overloading, and as a result the old stream channels were filled in (see Pl. XXX).

Dutton [29] describes similar clastic volcanic rocks in the High Plateaus of Utah and arrives at the same conclusions as the writer regarding their origin. He says: "The process which formed the conglomerates consisted in the transportation of fragmental matter from high-standing ancient volcanic piles to low-lying plains and valleys around their bases or along their flanks."

The present drainage system east of Mount Nebo has been reëstablished in essentially the same lines as those followed prior to the fill of the old drainage system. As a result, only patches of the water-laid, igneous material flanking the old channel walls are now left.

Origin. — The volcanic breccia in Payson Canyon to the north and a similar deposit in Thistle Creek Canyon to the northeast are the possible source areas of the volcanic conglomerate. Thin sections show all three to be composed of the same type of rock, and hence the probability of the derivation of the clastic volcanic rocks from the volcanic breccias. The dip of the cross-bedding and the gradation to finer material down the present channels corresponds in direction to that shown by the position of the probable source rock, the volcanic breccia, and therefore the conclusion is drawn that the volcanic conglomerate came from the north and northeast.

Age. — The water-laid deposit is younger than the Wasatch

[29] Dutton, C. E., "Geology of the High Plateaus of Utah," *U. S. Geog. and Geol. Surv., Rocky Mt. Region*, pp. 69–81. 1880.

conglomerate and in this respect correlates with the breccia. If the clastic deposit and the breccia were both derived from the same episode of volcanism they must be of approximately the same age.

If a great mud flow by which the clastics were deposited accompanied the eruption of the breccia, the two would be contemporaneous. Such a phenomenon may have occurred to form certain phases of the Salt Creek Canyon volcanic deposit, since parts of the darker division of the clastic rocks are so heterogeneous and unstratified and so many of the boulders angular that a viscous mud flow is a possible interpretation. For the most part, however, the stratification, sorting, and rounding demonstrate the deposits to be water-laid. This fact may lead to the assumption that the clastics are younger than the breccia by being an erosional derivative of it. Torrential rains, however, may have accompanied the eruptions which extruded the ash and fragmental material, depositing great quantities in the lower courses of the stream channels, thus effecting a simultaneous accumulation of the two volcanic-rock bodies.

The block-fault bounding the northeast end of the Gunnison Plateau has caused the partial burial of the clastic volcanic deposits in Salt Creek by large alluvial fans, and the block-faulting appears, therefore, to have postdated the deposition of the volcanic sediments. The writer is of this opinion, but he believes, however, that only a short period of time elapsed between the volcanism and the faulting, for reasons based upon physiographic evidence which will be presented in a future paper on the physiography of the region.

INTRUSIVE ROCKS

Dikes. — Loughlin has described in much detail two lamprophyre dikes in the area, one on the west face of Dry Mountain on the Black Balsam claim in Green's Canyon, and the other at the mouth of Bear Canyon, on the west slope of Mount Nebo.[30] To these intrusions may be added several other dikes and sills,

[30] Loughlin, G. F., *Two Lamprophyre Dikes near Santaquin and Mount Nebo, Utah, U. S. Geol. Surv., Prof. Paper 120–E*, pp. 101–109. 1918.

all of definite affinity. A group of small dikes occurring at the Nebo Highland Mine on the north side of Eva Peak, at the Eva Mine on the south side of the same peak, and in Bear Canyon about three hundred yards up from the mouth are all hydrothermally altered to such an extent that the exact nature of the original rock is undeterminable. They seem to bear closer similarity to the lamprophyre dikes than to any of the other types to be mentioned.

In the North Fork of Salt Creek Canyon, about two miles up from its junction with the main canyon, a wall of dull red to purple felsite extends across the canyon. It is about thirty feet wide, and on the east side stands fifty feet high. It is interpreted as a dike cutting the water-laid volcanic material described in the preceding pages. Thin sections show the rock to be a porphyritic andesite, and, as such, it corresponds with the effusive types into which it is intruded.

Sills. — Two sills were located, one intruded into the Cambrian quartzite in North Canyon, and one into the same formation in Loafer Mountain on the east slope of Payson Canyon just south of Rock Canyon.

The North Canyon sill is by far the largest post-Archean intrusive body exposed at the surface on the area mapped. It extends from the south slope of North Canyon north to Dry Canyon, but breaks in two places, cutting the bedding in very irregular fashion and terminating against brecciated limestone. Metamorphism is very slight. Sintering effects are all that are noticed in the quartzite; they extend only half an inch from the contact. The sill closely resembles the Salt Creek Canyon dike in color, mineral composition, and texture.

At the first bridge in North Canyon, where the sill disappears, dipping to the east, xenoliths of quartzite up to four feet long are observed embedded in the sill rock. The cross-cutting intrusion and the xenoliths prove it to be an intrusion into the Cambrian quartzite, and not an interbedded lava flow. The truncation on a spur of the Wasatch fault proves it to be preblock-faulting in age.

The intrusion at the Wilson prospect in Payson Canyon is

thought to be a sill. It parallels the Cambrian quartzite strata, but is of such short linear extent that the sill structure may be doubted. It is about one hundred feet thick; there is, however, only a very restricted zone of metamorphism along the dike walls. Copper showings were encountered at the surface, but nothing has since been struck in the prospect tunnel. Megascopically, it is also dark, dull red in color, somewhat like the North Canyon sill. Microscopically, it consists of a glassy ground-mass with prismoidal phenocrysts entirely replaced by calcite. The rock as a whole has suffered a great deal of hydrothermal alteration.

RELATION AND AGE OF EXTRUSIVE AND INTRUSIVE ROCKS

In conclusion, it may be said that the volcanic breccia, the water-laid volcanic ejectamenta, the dikes, and the sills all show petrographic relationships, and all apparently belong to the same eruptive epoch. This vulcanism occurred in post-Eocene time and shortly prior to the Basin and Range faulting.

ACKNOWLEDGMENT

This work was done under the helpful guidance of the Departments of Geology of Princeton University and the University of Utah. To the professors of these departments the writer is indeed grateful.

UNIVERSITY OF MICHIGAN

PLATE XXVII

Overturned fold in Jurassic shale; north side of Salt Creek Canyon

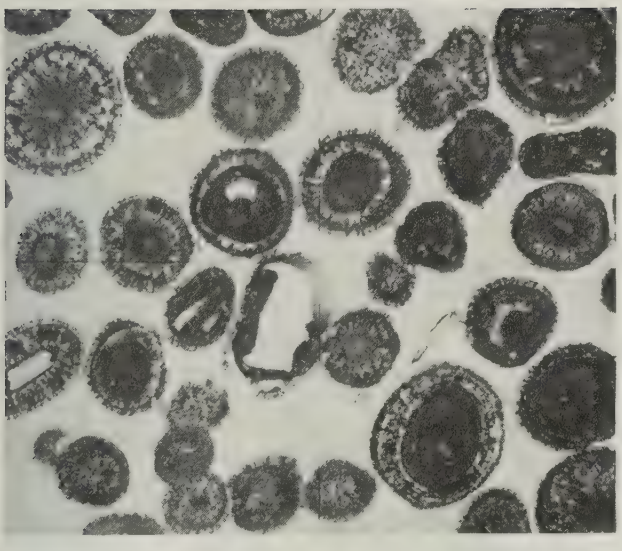


FIG. 1. Photomicrograph of Jurassic oölitic limestone. × 30

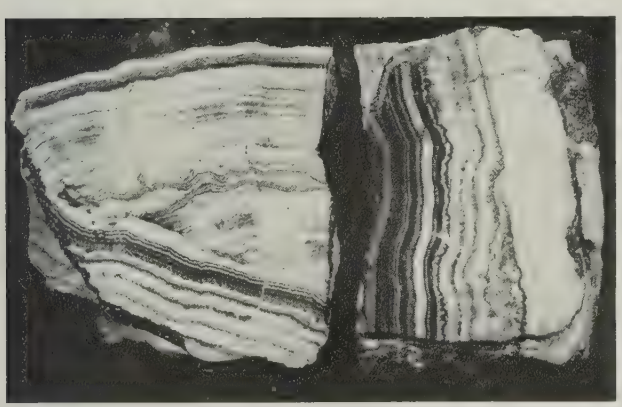
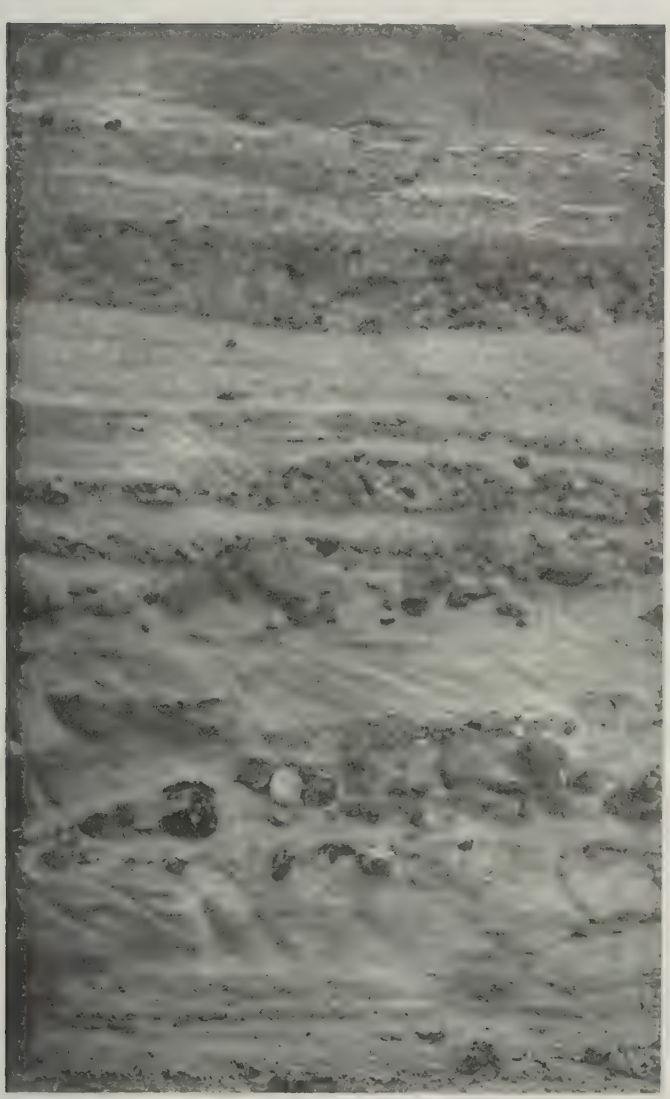


FIG. 2. Polished specimens of Jurassic travertine. × ½

PLATE XXIX



A twelve-foot section of volcanic conglomerate in Salt Creek Canyon

PLATE XXX

View down Salt Creek Canyon, with high South Ridge and Mount Nebo on the right. White formation in foreground is remnant of volcanic conglomerate which formerly filled old drainage channels now reëxcavated. It rests in contact with Wasatch conglomerate

A STUDY OF THE INSOLUBLE RESIDUES OF THE LOWER TRAVERSE, BELL, AND UPPER DUNDEE FORMATIONS OF MICHIGAN

GERALD E. EDDY

INTRODUCTION

THE correlation of the Lower Traverse, Bell, and Upper Dundee formations of Michigan is one of the difficult problems encountered in the study of the subsurface geology of the state. This is especially true of the Dundee formation. Geologists are of different opinions about the age relationships of the quarry sections and the samples collected from wells drilled in the drift-covered part of the state. In this paper the writer will attempt to show that there are definite characteristics by which the several formations may be recognized. Most of the five hundred samples prepared and examined were furnished through the courtesy of the Michigan Geological Survey. Additional samples were obtained from quarry sections, but there are only a few localities in the state where good exposures of these formations occur.

Certain characteristics have been found which indicate that correlations may be made over wide areas with a reasonable degree of accuracy. Not enough work has been done at present to enable one to distinguish the lower Traverse and Dundee formations from either older or younger beds; hence no attempt is made to discuss these relationships. It is highly probable that similar results might be obtained from studies of the older and younger strata in the Michigan Basin.

PREVIOUS STUDIES

The study of insoluble residues from calcareous well cuttings is not new. Methods for the examination of limestone samples

have been used as far back as 1920. In that year Trager [1] proposed a method by which the sand, shale, and limestone fractions of a residue may be separated and analyzed. The samples were first treated with hydrochloric acid and then centrifuged to separate the sand and shale portions. Lamar [2] carried out experiments in which he examined residues from the Chester Series of Illinois. He obtained the residues by treating the cuttings with hydrochloric acid. The size of the particles, the textural features of the limestone, the heavy minerals, and the microfossils were all considered in his paper. Claypool and Howard [3] have prepared residues from limestones by dissolving them in hydrochloric acid: the heavy minerals were separated by means of a centrifuge. The work upon which this paper is principally based was carried on in 1931 by H. S. McQueen [4] under the direction of the Missouri Bureau of Geology and Mines. His method involves the treating of the samples with dilute commercial hydrochloric acid and the examination of the residues thus prepared by means of a binocular microscope.

So far as the writer is aware, there has been no attempt to correlate Michigan limestones by any of these methods. All the correlations to date have been made from logs compiled by drillers, by the geologists of the oil companies operating in the state, and by R. B. Newcombe and O. F. Poindexter, under the direction of the Michigan Geological Survey, and have been based primarily upon their lithologic characteristics. Fossils found in the samples are practically valueless, owing to the fact that most of them have been destroyed by the drilling operations. Microfossils are significant, and considerable work has been done on them.

[1] Trager, Earl A., "A Laboratory Method for the Examination of Well Cuttings," *Econ. Geol.*, 15 (1920) : 170–176.

[2] Lamar, J. E., "Sedimentary Analysis of the Limestones of the Chester Series," *Econ. Geol.*, 21 (1926) : 578–585.

[3] Claypool, C. B., and Howard, W. V., "Method of Examining Calcareous Well Cuttings," *Bull. Am. Assn. Petrol. Geol.*, 12 (1928) : 1147–1152.

[4] See McQueen, H. S., "Insoluble Residues as a Guide in Stratigraphic Studies," Appendix I of *Biennial Report of the State Geologist*, 1931, pp. 102-110. Missouri Bureau of Geology and Mines.

PURPOSE OF THE STUDY

The purpose of this investigation was to study the residues prepared and to see whether there were any definite characteristics by which the lower Traverse, Bell, and upper Dundee formations could be correlated. The method was the same as that used by McQueen,[5] described in his paper on the Cambrian and Ordovician rocks of the Ozark region.

The topic was suggested by R. A. Smith, state geologist of Michigan, as possessing potentialities as a new method of correlating Michigan strata. The suggestion was made after he had been convinced by H. A. Buehler, state geologist of Missouri, of its great value in naming formations very difficult to recognize by means of their paleontologic or lithologic content.

METHOD OF PROCEDURE

The reaction of hydrochloric acid on magnesium and calcium carbonates is a familiar one and has long been known, but its application to the study of limestones and dolomites is comparatively recent.

The samples prepared were taken from limestone quarries or were obtained from the state survey files. Any weight from 2 to 30 grams may be used, depending upon the amount available. Samples of about 10 to 15 grams were found to be the most convenient. The cuttings were ground to pass a ten-mesh screen and placed in a 250 or 500 c. c. beaker. They were then covered with 50 c. c. of commercial hydrochloric acid diluted to half strength with distilled water. In some of the more violently effervescing limestones the acid must be added very slowly in order to decrease the strong immediate reaction. It was discovered good practice to add water to the sample first and then the acid to make up the 50 per cent solution. In the case of the more slowly effervescing limestones, shales, and dolomites, heating on a sand bath was necessary in order to be sure of complete digestion of the carbonates. Care must be taken not to leave the samples in the sand bath too long, because the mixture may become thick and gelat-

[5] *Op. cit.*, pp. 1–9.

inous, producing small crystals of gypsum. Gypsum is formed by the reaction between the sulphuric acid in commercial hydrochloric acid and the limestone or dolomite. After all reaction has ceased, the residues are washed by decanting off the clay and silt fractions. These fractions were not saved for examination, owing to their fine subdivision, which renders them too small for study. They also tend to obscure the nature of the larger, recognizable fragments. After washing, the samples were placed on a sand bath or in an oven and thoroughly dried. They were then put in glass vials for future study. It was found necessary to treat some samples with the acid a second time in order to have complete digestion and to remove the siliceous film on the grains of the siliceous carbonate rocks.

The equipment required varies, depending upon the number of samples to be run. The writer has been able to run as many as seventy-five samples in five hours, but this number could be greatly increased with more efficient equipment. It was found most convenient to run the samples in groups of twenty or twenty-five. In actual field work samples may be prepared with a simple field kit, and the examinations can be made with the ordinary hand lens.

The residues were examined with a binocular microscope. Low to medium magnification was used in order to obtain a fairly large field and still have a magnification high enough to enable one to recognize the different types of residues. Small, black cardboard trays were used to hold the specimens for examination. They measured about two by three inches by one-half inch deep. One corner was cut off to facilitate the pouring back of the samples into their vials.

About sixty photographs were taken of definite horizons. Those of the finer residues have a magnification of twelve diameters; those of the larger ones, of about eight diameters. Comparison of photographs was found to be much more reliable for correlation purposes than examination with the microscope, since the student has nothing to carry over from one slide to the next.

CHARACTERISTICS OF THE RESIDUES

The characteristics of the residues of the lower Traverse, Bell, and upper Dundee formations are quite variable, but they show enough contrast to be of value in indicating formational units as well as the larger stratigraphic divisions.

Shales are the predominant insoluble constituents of all the residues. They range from very fine, thin-bedded, micaceous shales to massive, coarse-bedded ones, which are shown in the residues as well-rounded particles or angular fragments.

Next in importance to the shales is the sand content. The grains vary from the very fine, angular, and poorly rounded type to the large and well-rounded. Some sands are frosted and others are not grains at all, but are well-developed crystals of quartz.

Other insoluble materials found in the residues are chert and secondary quartz in the form of irregular masses, and the very small fragments making up the siliceous shales. Other minerals that occur are pyrite, hematite, limonite, and magnetite. The writer did not examine these minerals in detail, since the study of the mass characteristics of the residues was the object of the investigation.

Another, and perhaps the outstanding, feature of the residues, was the occurrence of what McQueen [6] calls "dolocasts." He proposes this name because they are the impressions of the dolomite crystals in the insoluble chert, shale, or pyrite. To like structures found in the Michigan limestones the name "cast" is applied, because these features occur in residues not only from dolomite, but from limestones as well. These casts are formed by the deposition of silica and other insoluble materials in the interstices between the crystals of dolomite and calcite. The casts are of two types. To the first type, in which the intervening walls are thick and the openings caused by the dissolving out of the calcite are relatively small, the name "spongy" is given. In the second type the openings are large and the intervening walls are relatively thin. These are called "lacy." The occurrence of these casts seems to be more or less limited to zones close to unconformities, which the

[6] *Op. cit.*, pp. 111–131.

writer thinks indicates a tendency toward their development where there are extensive circulation of ground water and deposition of silica and pyrite.

FORMATIONS STUDIED

The formations studied in this paper are of Middle Devonian age, ranging from the upper Dundee, through the Bell Shale, to the top of the Long Lake Series at the base of the Traverse formation. The investigation did not extend farther up into the Traverse because the object was to distinguish between formations and not between the groups of series within a formation. The Bell Shale at the base of the Traverse presents an interesting problem because of its great difference in thickness and its total absence in some parts of the state. Figure 14 shows the Middle Devonian unconformity of western Michigan.[7] The study of the Dundee formation is also very interesting because of the occurrence of oil in it. The prominent erosion surface at its top and the irregular deposition in parts of the state make a study of this nature of considerable importance in the field of economic geology. A summary of the characteristics of the residues follows.

Long Lake Series

The Long Lake Series is a gray or dark gray, thin-bedded shaly limestone, locally fossiliferous, cherty, or bituminous. The bituminous property is distinctly observed in the preparation of the samples; the acid takes on an oily appearance, and the mixture gives off a strong odor of crude petroleum. Near the base of the formation are beds of chert and dolomite, which have been the source of well-developed casts.

The residues from wells in Muskegon, Newaygo, Midland, Crawford, Cass, Missaukee, and Livingston counties reveal a definite development of casts in the brown and gray shale members in the lower part of the series. In Plates XXXII, Figure 1, is illustrated the type of casts found in well No. 631 in Oceana County in a bed about one hundred feet above the top of the Bell-Traverse

[7] Newcombe, R. B., "Middle Devonian Unconformity in Michigan," *Bull. Geol. Soc. Am.*, 41 (1930) : 734.

contact. The residue here is a light brown shale, and the shape of the openings in the shale indicates that the dissolved mineral was probably dolomite. In Plate XXXI, Figures 1–2, there are shown casts in a gray shale. The openings are not so large or so well

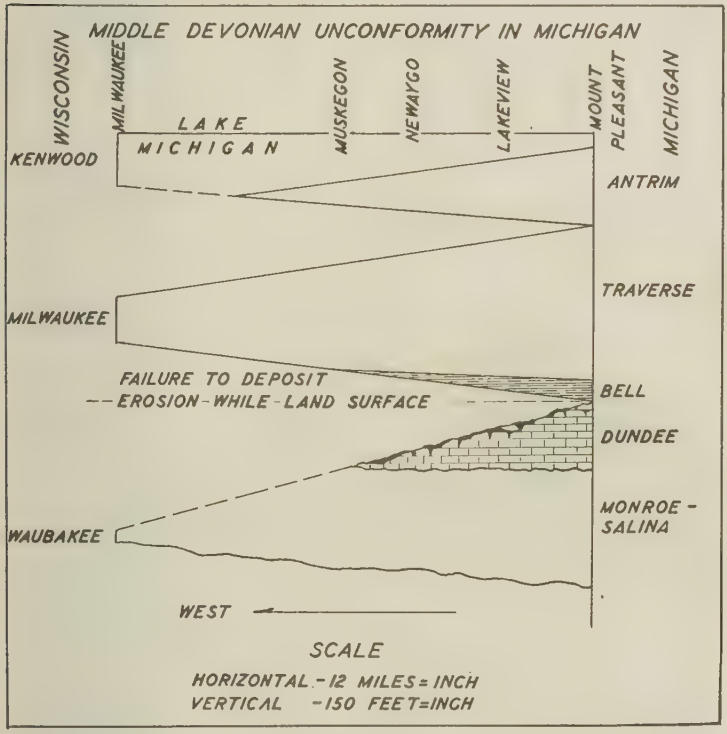


Fig. 14. Diagrammatic sketch of the Middle Devonian unconformity in western Michigan (after R. B. Newcombe)

developed as those in the brown shale beds. These casts come from a bed fifty feet above the top of the Bell-Traverse contact, and are from well No. 1133 in Missaukee County. In Plate XXXII, Figures 1–2, there are shown residues from beds one hundred

and fifty feet above the Bell-Traverse contact, respectively. Figure 1 is from well No. 1020 in Livingston County; Figure 2, from well No. 1177 in Wexford County. Another important difference in the residues from these two zones is the shape of the shale fragments. The fragments from the bed one hundred feet above the contact are very angular, whereas those from the bed fifty feet above the contact are rounded. This seems to indicate that the particles have been transported, and also that it is possible that they have been eroded from the Bell surface.

The casts in the brown shale are the best developed of the types found, and the presence of this type, together with casts in gray shale and chert, seems to point quite definitely to the beds in which they occur as belonging to the Lower Long Lake Series. The only places where these casts do not occur are in two wells in Newaygo County. Here the residues consist of irregular, secondary quartz fragments showing iron staining, which gives a brown color to the residue as a whole.

Bell Shale

The Bell (Marcellus) Shale, which is blue or black to dark gray, is locally fossiliferous. In some parts of the state it is missing; in others its maximum thickness is eighty feet.

The insoluble residues consist principally of a massive shale. "Massive," in this sense, means a shale coarse-bedded and also lacking casts. The fragments are light to dark gray. They are either well rounded or sharply angular. Though some have the same shape as those found in the bed fifty feet above the Bell in the Traverse, they differ in that they are massive (see Pl. XXXIV, Fig. 1). There are some very fine, well-developed casts in a brown shale, but it is probable that they originated in the Long Lake Series and have become mixed with the Bell cuttings as a result of caving or slumping in the hole. They are almost identical with those already described. Care must be taken not to misinterpret these apparent results. It was concluded that they fall in the Long Lake Series because of their striking similarity and also because they occurred in only two of the twelve wells sampled. There are a few casts in a brown shale that are not like the ones men-

tioned. They are coarser and possess what might be called a drusy structure. They also resemble very fine solution channels.

The residues of samples from the eastern part of the state are fairly consistent, but those from wells in the western part show a great variation which seems to indicate different conditions of erosion or non-deposition of the Bell Shale. They vary from gray, massive, black, well-rounded or angular gray shales to very fine angular silt (see Pl. XXXIII, Figs. 1–2).

Dundee limestone

The Dundee formation is gray and buff crystalline limestone, locally cherty, fossiliferous, and bituminous. Sulphate waters and highly mineralized brines occur in the lower beds; oil is found in commercial quantities in the upper beds. The thickness ranges from sixty-five (?) to two hundred and fifty feet.

Samples of the formation were taken from nineteen wells and two quarries. It was found that the residues from the Dundee are the most variable of those studied. The first ones examined were of rock specimens from the Rogers City quarry in Alpena County and from the Calcite quarry in Presque Isle County in the northeastern part of the state and from the Sibley quarry in Wayne County in the southeastern part. These localities were selected with the idea of correlating the horizons from these areas with the beds in the Mount Pleasant field and also with the "Dundee" in the Muskegon field in the western part of the state. There are but few complete sections of the Dundee available in the oil fields because the drilling usually has ceased as soon as oil is struck in its upper beds. Only six of the nineteen wells sampled penetrated through the Dundee into the Detroit River group.

The residues from the rock quarries in Alpena and Presque Isle counties were found to be quite different from those of the Sibley quarry in Wayne County. Sands are the predominant constituents in the residues from both areas, but they differ in size and shape. The residues from the northern area show an angular to subangular type of grain which is, in general, larger than the angular grain of the southeastern area. The residues from several beds of the Sibley quarry have a well-rounded type. Many of the grains

are also frosted (see Pl. XXXV, Fig. 2). This rounding of grains may be due to a greater amount of transportation or to the action of solutions. J. J. Galloway [8] says that the rounding may be done by solutions in a manner similar to the process of exfoliation. The size of the largest grain that may be formed in this way is given as 0.1 millimeter, so that it seems more likely that the grains in the Sibley section are caused by abrasion and not by solution. There are, in addition to the rounded grains, very fine angular grains in several beds. These are very small, and hence their angularity does not mean that they have been subjected to less mechanical transportation and abrasion than the rounded type. It is much more probable that it is due to the fact that their size is below the theoretical limit for mechanical abrasion. That is, they are so small and their mass is so slight that the water film between the particles is sufficient to hold them apart (see Pl. XXXIV, Fig. 2).

At a level about twenty-five feet below the top of the section are two chert beds about six feet apart. These cherts are massive, with but a poor development of casts. Residues from them are illustrated in Plate XXXV, Figure 1.

The top seven feet of the section presents a good development of casts in a very thin bedded brown shale. They are of the lacy type, with thin walls between the openings.

The predominant constituent from well No. 130 in Macomb County is a rounded type of sand grain. In addition to these grains there are a few beds containing grains of the very fine angular variety of quartz (see Pl. XXXVII, Fig. 1); one bed about fifty feet from the top of the formation containing abundant pyrite masses; and one bed of slightly castic chert at about the same horizon. There was also one horizon in which casts occurred. They are in brown shale and are very fine and poorly developed. They are similar to those in the upper seven feet of the section at Sibley quarry.

The predominant constituent of the residue from well No. 130 in Lenawee County is pyrite. This mineral is principally of the

[8] Galloway, J. J., "The Rounding of Sand Grains by Solution," *Am. Journ. Sci.*, Fourth Ser., 47 (1919) : 270–280.

crystalline variety. In addition to it there are several samples with the typical rounded grains of sand, as described above. The massive chert beds of the same age as those noted at Sibley quarry were also found. There were several fragments of black shale, but it is most probable that they are cavings from the overlying Bell Shale.

Rounded grains of quartz are the most characteristic features in the residues from well No. 1020 in Livingston County. They vary from white through brown to a deep reddish brown. This coloring is due to limonitic staining, which gives a brownish color or cast to the residue as a whole.

In the last six paragraphs there is given a summary of the characteristics of the residues from wells in the southeastern part of the state. It will be noted that large, rounded sand grains occurred in every section sampled. The writer, however, did not find grains of this type in any other section studied with the possible exception of a few in the hand specimens from the Rogers City quarry in Alpena County.

In the northeastern part of the state samples were obtained from four wells and from the Calcite quarry in Presque Isle County and from the Rogers City quarry in Alpena County. The wells are in Presque Isle, Alpena, Crawford, and Ogemaw counties. For an exact location of the wells sampled see Map 32.

The samples from the quarries were given to the writer by G. M. Ehlers and were obtained from the collection of the University of Michigan Museum. Though their geographical location is known, their stratigraphic position was not definitely established. As already stated, the sand grains are angular and differ from the residues from the southeast part of the state only in their size. The grains in the northern area are much larger and seem to indicate less abrasion, and hence a smaller distance from the source to the point of deposition. There is one sample that has a non-castic chert residue, and two contain abundant pyrite and hematite which have no counterpart at Sibley quarry.

The residues from well No. 830 in Alpena County show an angular quartz grain, a few beds of siliceous shale, and a mixed residue of pyrite, brown and black shale about one hundred feet

from the base of the formation. There are a few good casts from a bed about forty-five feet from the top of the formation.

In cuttings from Campbell No. 1 well in Alpena County the residues from the top seventy-five feet consist of an impure cherty

Map 32. Location of wells and quarries from which samples were secured

quartz, all the fragments of which are very angular or are irregular, crystalline masses. An increase in amount up to 40 per cent was noted. The cherty quartz also changes to an impure chert. The

lower sixty feet has a residue of angular, crystalline quartz and cherty quartz.

In well No. 1143 in Ogemaw County the top seventy-five feet has a residue consisting of a light gray, thin-bedded shale. The particles of shale are massive and well rounded. Below this there is a bed of irregular, smoky quartz and chert, which is a decided change from the overlying beds. These are followed by forty feet of brown to gray shale, containing casts in the brown shale and considerable amounts of pyrite and hematite. Below these beds are ten feet of gray shale and very fine sand grains cemented together to form features resembling casts. The fine sands persist downward for an additional ten feet; this in turn gives way to a few feet of impure chert, which is slightly castic. This is followed by massive shale containing abundant hematite, especially in the last twenty feet of the section.

The residues from Grayling No. 1 well in Crawford County are principally fine-bedded, siliceous gray shales and a few rounded, frosted quartz grains. Crystalline pyrite is quite common, and there are also a few particles of blue, irregular, massive quartz.

All these samples are from the northeastern part of the state. To summarize, the outstanding characteristics of the residues from this area are the angular, large sand grains and a greater abundance of either crystalline or massive pyrite (see Pl. XXXVI, Fig. 1). In one well the percentage of pyrite in some of the cuttings runs as high as sixty. The residue from the Grayling well differs from those of all the rest in that the principal constituent is siliceous shale, thin-bedded and entirely lacking in casts.

Cuttings from wells in Newaygo, Oceana, and Muskegon counties were studied and the following points noted:

The residues from this area were the most variable of those examined. There seemed to be a greater difference over a much smaller area than from any wells in other sections of the state. In other areas the residues seem to show a distinct similarity, as the descriptions given above indicate.

In well No. 631 in Oceana County the residues consist of fine, poorly rounded to angular quartz grains. In well No. 346 in Muskegon County the residue is a light gray shale whose fragments

are well rounded. This feature was found elsewhere only in wells in the central part of the state. The residue from well No. 788 in Newaygo County is a brown sand. The grains are chiefly rounded and frosted, with a few grading over into the angular type. All are iron-stained and are very similar to the ones from well No. 654 in Newaygo County. In addition to these features there were also found clear, crystalline quartz and a few fragments of magnetite partly altered to limonite. In well No. 696 in Newaygo County the residue consists of gray shaly fragments, some angular quartz, and a few grains of the rounded type.

Residues from four wells in the central part of the state were prepared and examined. They differed widely from any other Dundee samples, with the exception of that from well No. 346 in Muskegon County. A description of the residues is given in the succeeding paragraphs.

In No. 73 in Midland County the residue consists chiefly of a gray to brown shale, the fragments of which are fairly well rounded. This feature is shown in Plate XXXVI, Figure 2. There are also some thin-walled casts in chert and a fairly abundant occurrence of pyrite. In well No. 982 in Mecosta County the residue is also chiefly a shale. The particles are clearly rounded. The color of the shale varies from gray through brown to black. The next most common feature was the great abundance of pyrite. This mineral occurs in all but twenty of the one hundred and twenty feet in the section and is of both the massive and the crystalline varieties. Limonite also occurs in beds near the base of the section. The residues from well No. 1149 in Isabella County are much the same as those from well No. 982 in Mecosta County, with gray, brown, and black shales predominating. One horizon contained rounded quartz grains like those found at Sibley quarry. This is shown in Plate XXXVII, Figure 2. Near the base of the section the residues grade into much darker shales, some of which are almost coal-black (see Pl. XXXVIII, Fig. 1). In well No. 8 in the Saginaw field the residues of the entire Dundee section consist of shale fragments, all of which are distinctly rounded (see Pl. XXXVIII, Fig. 2). There were a few casts in pyrite and chert, but they occur in quantities so small that they are not significant. A few beds of

brown shale occur in which there are what appear to be casts, but it is more probable they are the result of solution by ground water.

SUMMARY AND CONCLUSIONS

The depositional features of the Michigan Basin are found to be much different from those in any other part of the country. Sediments have been laid down in fluctuating basins and between the structural ridges, which have acted as natural barriers to the migration of the several types of fauna. The seas that entered the Michigan Basin have come from several different directions and the barriers have kept them from intermingling.[9] G. M. Ehlers [10] is of the opinion that the Dundee section of the Calcite quarry is of a different age from that of the Sibley quarry. He bases his opinion on the difference in the faunal life. Some species that occur in the northern section of the state are not represented in the southeastern part, and vice versa. R. A. Smith [11] is of a similar opinion. In the study of the residues no features were found which the writer could be sure occurred in both areas. It was ascertained, however, that the residues were consistent over small areas. This fact seems to bear out the idea of R. B. Newcombe [12] that at the end of Dundee time there was a long period of erosion or non-deposition of marine sediments. This is also shown by the fact that the Dundee varies as much as two hundred feet in thickness over comparatively short distances.

The residues from the Dundee formation in the Mount Pleasant field are much different from any that occur elsewhere in the state. They do not conform to typical Dundee "purity," owing to the fact that the principal constituent is shale, gray to brown. It was first thought that they were cavings from the overlying Bell Shale because the fragments were all well rounded. They occur much too consistently for this to be true. The presence of this shale would seem to indicate that the Dundee in this locality is a shaly facies, having been laid down in close proximity to some land mass.

[9] Newcombe, R. B., "Depositional and Structural Features of the Michigan Synclinal Basin," pp. 94-97 of unpublished manuscript. June, 1931.

[10] Oral communication.

[11] Oral communication.

[12] *Op. cit.*, pp. 161–164.

In the western part of the state the residues are not at all consistent. The area studied includes Oceana, Newaygo, and Muskegon counties. Even in so small an area the residues from the different wells do not correspond as closely as those from samples from other parts of the state. This is probably due to erosion or nondeposition of the Dundee beds. Newcombe [13] says that there is an east–west area across Oceana, Newaygo, and Muskegon counties with smaller basins paralleling it on either side. This structural feature no doubt accounts for the lack of similarity in the residues. With one exception those from all the wells are characteristically "Dundee" in that they consist of sand grains. They are usually brown, owing to limonite staining.

The Bell formation has a residue consisting entirely of shale fragments. They may be either distinctly rounded or subangular. This feature is most prominent in wells from the central and the eastern parts of the state. The residues from wells in the Muskegon area do not seem to be so consistent. This is not surprising, since the Bell Shale was laid down in a sea progressively overlapping to the west.[14] The Bell has never been found in wells in the southwestern part of the state. The oscillatory nature of the sea bottom caused the alternating beds of shale, limestone, and calcareous shale.[15]

The residues of the Long Lake Series appear to be the most consistent of those examined. Two horizons were found which have the same characteristic type of residue. It was in the Long Lake Series that the good casts were discovered. There were two zones in which they were especially common. These zones are fifty and one hundred feet above the top of the Bell Shale. The casts from the two zones differ in the shape of the shale fragments in which the residues occurred. Those from the lower horizon are in pieces of rounded shale; those from the upper beds, in fragments of angular shale.

It is not true that all residues from the same horizon have the same characteristics. There are small differences, the addition of

[13] *Op. cit.*, p. 163.
[14] Newcombe, as cited in note 7, pp. 725–738.
[15] Newcombe, as cited in note 9, p. 258.

PLATE XXXI

FIG. 1. × 8

FIG. 2. × 8

RESIDUES OF THE LONG LAKE SERIES

Samples are from beds fifty feet above the top of the Bell Shale

FIG. 1. × 8

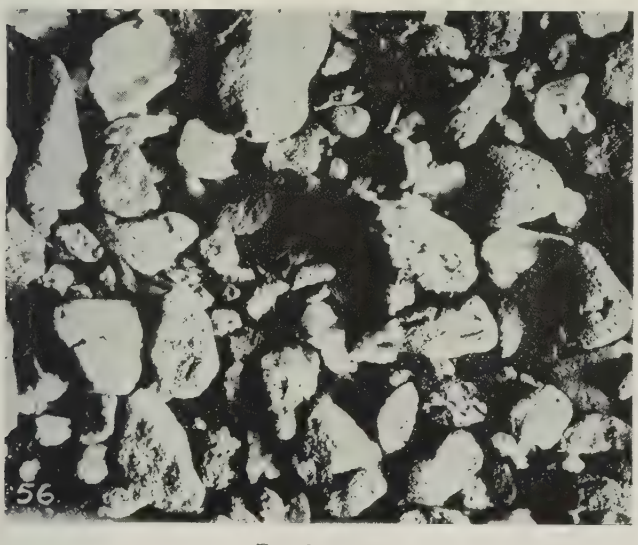


FIG. 2. × 8

RESIDUES OF THE LONG LAKE SERIES

Samples are from beds one hundred and fifty feet above the top of the Bell Shale

PLATE XXXIII

FIG. 1. × 8

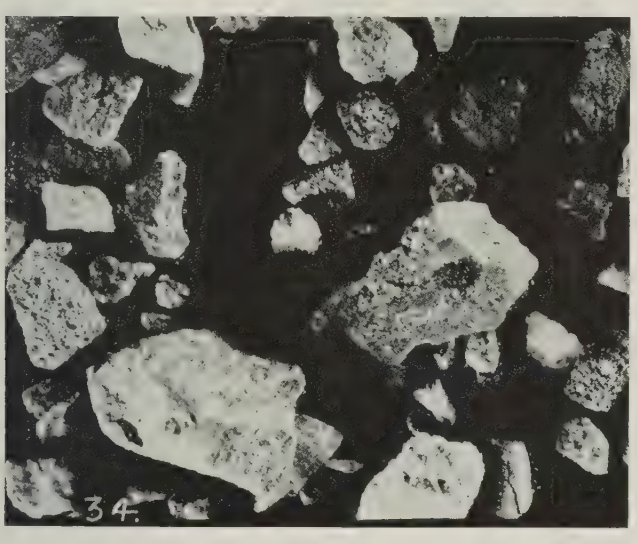


FIG. 2. × 8

RESIDUES OF THE BELL SHALE

Fig. 1. × 8

Fig. 2. × 8

CHARACTERISTIC RESIDUES OF THE DUNDEE FORMATION

Samples are from a bed fifty feet below the top

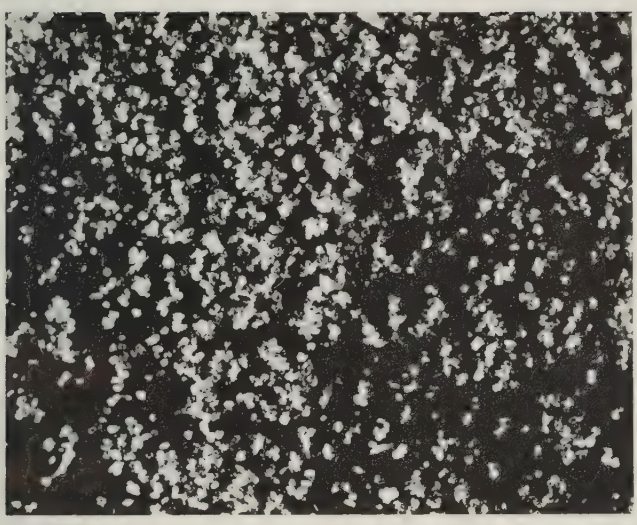


FIG. 1. × 12

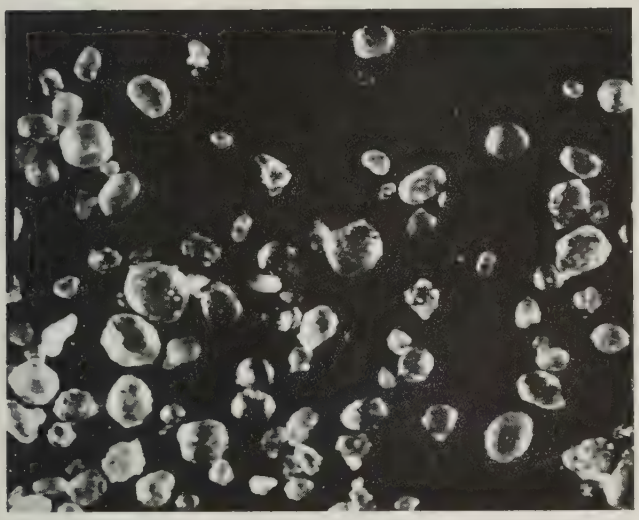


FIG. 2. × 12

CHARACTERISTIC RESIDUES OF THE DUNDEE FORMATION

Samples are from a bed fifty feet below the top

FIG. 1. × 8

FIG. 2. × 8

CHARACTERISTIC RESIDUES OF THE DUNDEE FORMATION

Samples are from beds fifty feet below the Bell Shale

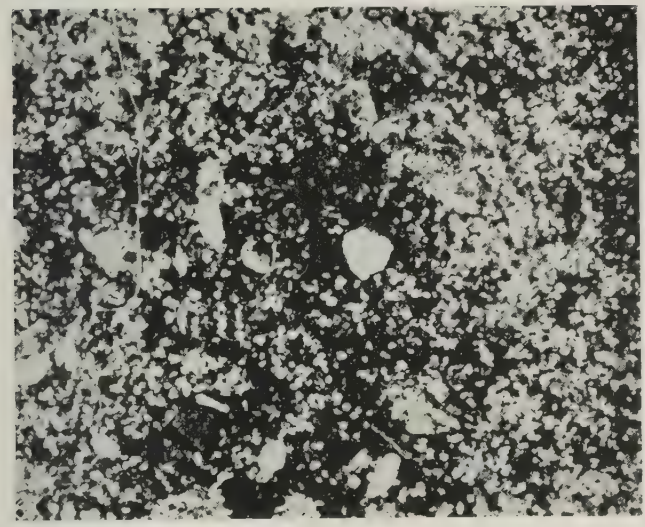


FIG. 1. × 12

FIG. 2. × 12

CHARACTERISTIC RESIDUES OF THE DUNDEE FORMATION

Samples are from a bed one hundred feet below the top

FIG. 1. × 8

FIG. 2. × 8

CHARACTERISTIC RESIDUES OF THE DUNDEE FORMATION

Samples are from a bed one hundred feet below the top

new material or the loss of others. They are of minor importance, since the main and characteristic features are the significant things by which the zones may be recognized.

Erosion surfaces may be located by this method. A good circulation of ground water is conducive to the formation of good casts by furnishing abundant insoluble material.

It is very probable that further work would shed much more light on the problem, and this paper is written with the purpose in mind of stimulating further investigation in the study of insoluble residues.

ACKNOWLEDGMENTS

The writer is greatly indebted to the following persons for helpful suggestions and invaluable aid in the preparation of the paper: To Dr. C. W. Cook, under whose direction the investigation was carried on; to R. A. Smith and R. B. Newcombe of the Michigan Department of Conservation, who have made the work possible; to Drs. G. M. Ehlers and E. C. Case of the University of Michigan; to L. W. Price of the Michigan Department of Conservation, who prepared all the well samples examined by the author; and to H. S. McQueen of the Missouri Bureau of Geology and Mines.

University of Michigan

GREENLAND, THE ADVANCES OF A DECADE (1921–1931)

WILLIAM H. HOBBS

INTRODUCTION

THIS is notably an era of polar exploration, and nowhere is inquiry proceeding more rapidly than on the land-mass of Greenland, which convention seems to have designated an island, though it is very largely submerged beneath one of the two continental glaciers which still exist. Greenland's history is so largely concerned with this glacier that I prefer to regard it as a continent.

Up to the year 1921 no authoritative work treating of Greenland had been published since H. Rink's *Grönland* (1852 57) and his *Danish Greenland, Its People and Products* (1877), the latter printed in the English language. In 1921 occurred the two-hundredth anniversary of the landing of the first missionary, Hans Egede, on the west coast, with which event the modern history of Greenland begins. As part of the notable celebration of this anniversary, in which the Danish sovereign paid a ceremonial visit to his great northern colony, there was published in the Danish language a great work of compilation in two massive volumes entitled *Grönland.*[1] In 1928 there appeared in English a magistral work in three volumes with the same title (*Greenland*),[2]

[1] *Grönland i Tohundredaaret for Hans Egedes Landing, udgivet af Kommissionen for Ledelsen af de Geologiske og Geografiske Undersögelser i Grönland, under Redaktion af G. C. Amdrup, Louis Bobé, Ad. S. Jensen, H. P. Steensby.*† Vol. 1, 567 pages; Vol. 2, 795 pages. Illustrated. C. A. Reitzel, Copenhagen, 1921.

[2] *Greenland*, published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland. Editors, M. Vahl, Ph.D. (chief editor), G. C. Amdrup (Vice-Admiral), L. Bobé, Ph.D., Ad. S. Jensen, Ph.D. Vol. 1 (*The Discovery of Greenland, Exploration, and Nature of the Country*), 575 pages; Vol. 2 (*The Past and Present Population of Greenland*), 415 pages; Vol. 3 (*The Colonization of Greenland and Its History until 1929*), 468 pages. Illustrated. C. A. Reitzel, Copenhagen. 1928 and 1929.

and with three of its four editors the same as those of the Danish work, namely: Vice-Admiral Amdrup and Drs. L. Bobé and Ad. S. Jensen, but under the chairmanship of Dr. M. Vahl, professor of geography at the University of Copenhagen.

The Danish language work had, however, a wholly different plan, since it treated each of the twelve districts of Greenland separately, whereas in the later work printed in English separate authoritative articles in Volume I discussed the entire country with respect to: early explorations, scientific investigations, cartography, geographical situation, surrounding waters, geology, climate, flora, vegetation, fauna, inland-ice, and physiography.

The appearance of these comprehensive surveys of Greenland makes the date of the issue of the earlier work a convenient point from which to take up later work in many lines, and I shall therefore here discuss the developments since 1921. Both before and since that date much of what has been learned of Greenland is to be found in that magnificent publication, *Meddelelser om Grönland* ("Contributions on Greenland"), issued by the Commission for the Direction of the Geological and Geographical Investigations on Greenland, a commission which dates from 1877 and which has already issued more than eighty volumes. The earlier volumes were printed in the Danish language, sometimes with brief French abstracts appended, but beginning with the eleventh volume (1887) an ever-increasing number of the monographs have appeared in the better-known European languages, German, English, or French. Few countries can boast a more magnificent series of scientific publications devoted to a single subject, and this is true both as to subject-matter and to dress, thanks to the generous grants made from the Carlsberg and Rask-Oersted Foundations.

SURVEYS

Until within the last decade surveys of Greenland have been carried out largely by traverses of coasts and navigable fjords, checked by a considerable number of astronomical observations, but all before the use of radio time signals. These surveys have in general been much more complete for the far more accessible west coast to the southward of Upernivik (in latitude 72° 45′ N.).

In 1927 the Danish Government began work on a new map of Greenland. A base line 600 meters long was laid out on the island of Disko on the west coast, and between 1928 and 1930 a primary triangulation was partly completed for the coastal area between Jakobshavn on the south and Upernivik Island just north of Umanak. This survey, begun by the General Staff of the Danish Army, is now being prosecuted by the newly organized Institut Géodésique, in which the Topographical Division of the Army General Staff has been combined with the Geodetic Service under the Ministry of War (N. E. Nörlund, 1930). Some preliminary flying by naval seaplane has been carried out for aërial map work.

In addition, a precise determination of the position of Kornok, near Godthaab in southwest Greenland, was made in 1927 — a station which had been used for the same purpose before the advent of radio time signals and which is now to be made permanent. The latitude of this station has now been determined as 64° 32′ 6″. 28 ± 0″ . 10, and the difference of time Greenwich–Kornok as $3^h\ 24^m\ 23^s$. 405 ± 0^s . 008.

MAPS

Up to the date of the Two Hundredth Anniversary in 1921 the latest official map of Greenland bore the date of 1906 8 and was printed on a scale of about 1:2,000,000. In connection with the work *Grönland*, published to commemorate the anniversary, there was issued an atlas which included separate physical and geological maps of Greenland on a scale of 1:10,000,000, and, in addition, district maps on a scale of 1:1,000,000, of each of the eleven administrative districts: Egedesminde and Christianshaab; Jakobshavn, Ritenbenk and Godhavn; Umanak; Upernivik; Thule; Holstensborg; Sukkertoppen; Godthaab; Frederikshaab; Julianehaab; and Angmagssalik. In addition, the atlas included plans of the settlements (colonies) and historical maps of the house ruins of each of the principal settlements of the tenth century.

In 1926 the Danish Government issued a new and much improved general map of that part of Greenland which is south of 75° north latitude, or south of Melville Bay on the northwest coast, on a scale of 1:2,000,000, with an inset map of the entire

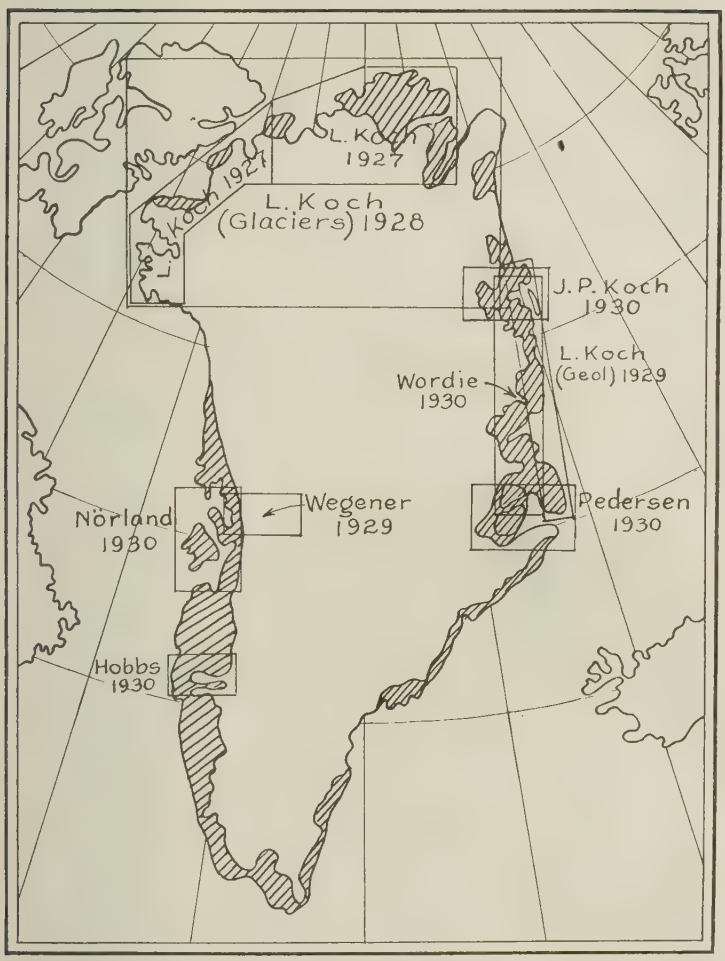
country on a scale of 1:6,900,000. This is the best general map of Greenland available today and, like all official maps of Greenland, it is obtainable from the publisher, C. A. Reitzel, 7 Lövstrade, Copenhagen. Of special use to English-speaking readers is the map with English place names, prepared by Professor M. Vahl and issued in 1929 in connection with the three-volume work *Greenland*, but obtainable separately. This map is on a scale of 1:4,000,000.

The American Geographical Society, which has devoted so much attention to the polar regions, brought out in 1930 a Physical Map of the Arctic on a scale of 1 : 20,000,000 (Joerg, 1930*a*). In the same year the Scientific Cabinet of the Prince of Monaco issued three of a total of four sheets of a general bathymetric map of the northern oceans, on which north Greenland is represented on a large scale, copied from existing maps. Also in 1930 a geological map of the Arctic regions was published by Otto Holtedahl (Holtedahl, 1930).

Special areas of Greenland have been studied and maps have been published since 1921; those of Danish origin generally in the *Meddelelser*, the others scattered. These areas are roughly indicated on Map 33. The area of the north Greenland coast land, from Melville Bay on the west to Cape Bismarck on the east, has been mapped by Dr. Lauge Koch, in part while cartographer and geologist of the First Thule Expedition under Dr. Knud Rasmussen, and in part on his own expedition (L. Koch, 1927, 1928*a*).[3] The east coast south of Cape Bismarck as far as Scoresby Sound he has mapped and studied geologically on later expeditions and has issued a colored geological map (L. Koch, 1929*b*).

The Cambridge University Expeditions of 1926 and 1929,

[3] In 1931 there was issued a portfolio of maps of north Greenland, on a scale of 1:300,000 of the area which was surveyed by Lauge Koch in the years 1917–23. This portfolio, published by the Geodetic Institute of Denmark, includes eighteen plates executed in nine colors and giving altitudes, and a supplement. Each of the maps covers an area of about 20,000 square kilometers. The individual maps are designated Beaumont Island, Lockwood Island, Cape Morris Jesup, Cape Bridgman, Hall Land, Black Horn Cliff, Wulff Land, Adams Biering Land, Navy Cliff, Denmark Fjord, Cape Constitution, Petermann Glacier, Etah, Cape Agassiz, Cape Parry, Inglefield Gulf, Cape Atholl, and Cape York. These maps are sold by Levin & Munksgaard, Copenhagen.



Map 33. Sketch map showing the areas covered by special maps of Greenland published since 1921

commanded by J. M. Wordie, have mapped parts of this long shore line and prepared detailed maps of the neighborhood of

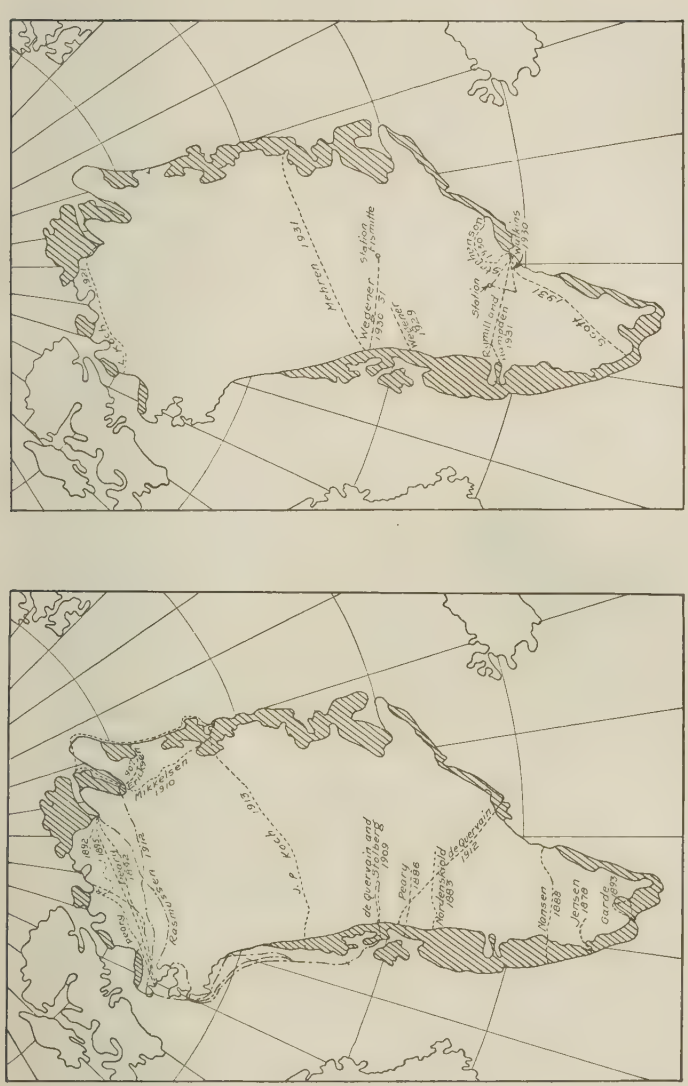
Petermann Peak and the Nordenskjöld Glacier (Wordie, 1930*a*, 1930*b*). The difficult ascent of Petermann Peak was accomplished and the altitude of the summit fixed as 9,650 feet, more than 1,200 feet higher than Nathorst's determination.

About Scoresby Sound itself some important surveys have been made by Alwin Pedersen, who has published a small map of the district (Pedersen, 1930). Pushing his way past a blockade of icebergs frozen into the remote Northwest fjord, he discovered an ice-free area with an abundance of game animals. In 1931 Louise A. Boyd in the *Veslekari* carried out a photographic survey of both Franz Joseph and King Oscar fjords on the east coast and published a map (Boyd, 1932).

On the west coast the University of Michigan Expeditions, of which Dr. Ralph L. Belknap has been cartographer, have prepared maps of the hinterland of the Holstensborg district about Mount Evans (Hobbs, 1927, 1930, 1931*b*). Dr. Alfred Wegener, who has since perished on the Greenland ice-cap, published a sketch map of the coast district north of Umanak, including his sled trips on the ice-cap in the summer of 1929 (Wegener, 1930*a*, 1930*b*). Preliminary reports on his main expedition of 1930 31, which was exceptionally fruitful of results, have now appeared (Else Wegener, 1932, and Berlin Geog. Soc., 1932).

The east Greenland coast of the Angmagssalik district from the Sermalikfjord to Kangerdlugsuatsiak has been surveyed from the air by the British Arctic Air Route Expedition of 1930–31, under command of H. G. Watkins (Brit. Exped., 1930), who has since perished in Greenland. Mount Forel is estimated to be 11,200 feet high. A party under Stephenson of the British Expedition attempted in May, 1931, to climb this mountain and succeeded in reaching an altitude of 10,880 feet. The summit they estimated to be at 11,500 feet. In the same district this party climbed a nunatak to the summit at 10,500 feet latitude.

New transection reconnaissances of the inland-ice, either complete or partial, have been carried out during the decade just past, as follows (Map 34): (*a*) in 1929 by Dr. Alfred Wegener, from the Kamarujuk Glacier on the west coast near latitude 71° eastward for a distance of 130 miles and also from Quervainshavn near

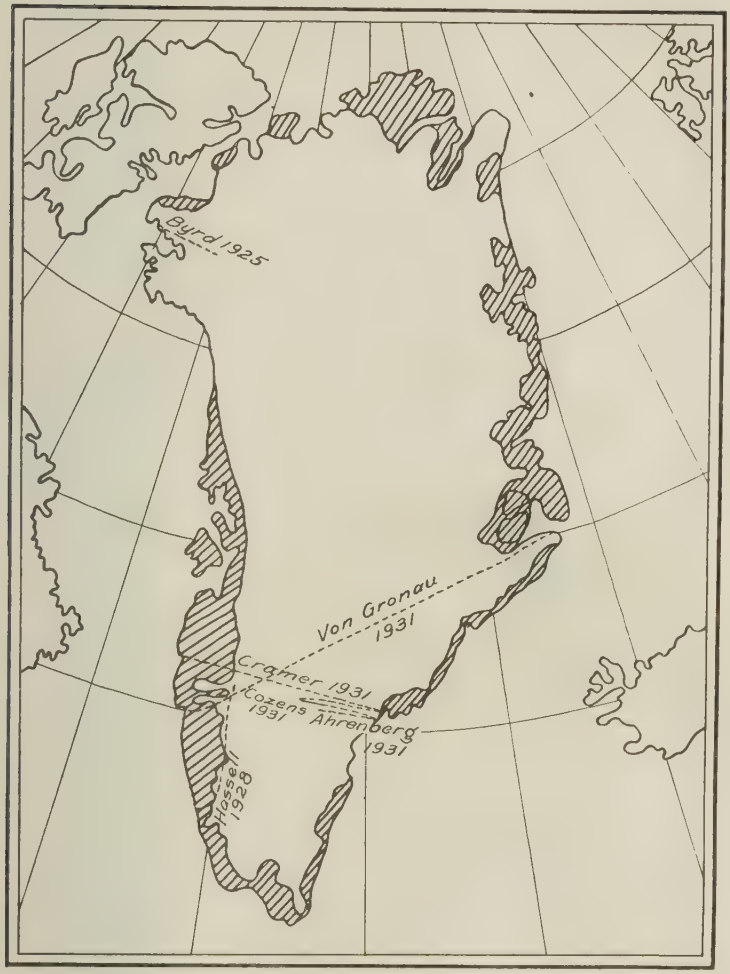


MAP 34. Sledge routes of explorers: at left, before 1921; at right, 1921–31

latitude 69° northeastward a distance of 93 miles; (*b*) in 1930 by Wegener's party several times from Kamarujuk Glacier to Eismitte, the camp established on the medial line of the ice-cap 250 miles away (Wegener, 1930*a*, 1930*b*); and in 1931, after Wegener's death, several times by members of his expedition (New York *Times*); (*c*) in 1930 and 1931 several times by Watkins' parties, from the British Air Route Expedition base near Angmagssalik to their central ice station on the crest of the ice-cap, and, once, southward from the station down slope a distance not definitely stated (Brit. Exped., 1930; *The Polar Record*, No. 2, 1931); (*d*) in June and July, 1931, by three members of the British Air Route Expedition under James M. Scott, from Angmagssalik on the east coast southwestward behind the coastal mountains to the latitude of Umivik Bay, and thence direct to Ivigtut on the south coast; and (*e*) in the summer of 1931 by Rymill and Hampden, from Angmagssalik westward past Mount Evans to Holstensborg. The Norwegians Mehren and Höygaard in the summer of 1831 crossed from Umanak on the west coast to the east coast at Gael Hamke Bay (Höygaard, A., and Mehren, M., 1931). On his main expedition of 1930–31 Wegener carried a series of precise levels from the Kamarujuk Glacier on the west coast in lat. 71° 10′ N. over the inland-ice to the central station of Eismitte (Else Wegener, 1932, and Berlin Geog. Soc. 1932).

Reconnaissance by airplane over the Greenland ice-cap was first attempted by Lieutenant Commander, now Rear Admiral, Richard E. Byrd, when in 1925 with the late Floyd Bennett he flew over the ice-cap in the Loening amphibian NA 1 from Igloohouny in the Cape York district, an estimated distance of about 40 miles in a direction south of east, where from an air elevation of 11,000 feet, with excellent visibility, he viewed the ice-cap for a distance of a hundred miles (Byrd, 1925). His claim that the ice surface rose to the level of his plane (11,000 feet) seems unlikely in view of the known altitudes reached by sledging parties in that district [4] (Map 35).

[4] The highest point of the ice-cap surface yet reached is at an altitude of 10,463 feet, on the divide passed by J. P. Koch in 1913 (Koch, J. P., and Wegener, A., 1930).



Map 35. Flights over the ice-cap of Greenland

The next flight over the ice-cap was made by Bert H. J. Hassell and Parker Cramer on August 19, 1928, when they flew in a

Stinson monoplane partly over and partly off the ice-cap from east of Fiskenæsset on the southwest coast near latitude 62° northward and across the broad Knud Rasmussen ice-arm until forced down on the ice about 40 miles southeast of Mount Evans (Hobbs, 1930).

On February 25, 1931, Cozens and Scott of the British Expedition flew in a Moth plane from the Angmagssalik base on the east coast due westward to near the medial line of the ice-cap in an unsuccessful attempt to find the central station of the Expedition. In May of the same year Captain Albin Ahrenberg of Stockholm flew from the same base westward an estimated 130 miles in an attempt to rescue Courtauld, but found Watkins' sledge party returning with the rescued man.

The first crossing of the ice-cap by plane was accomplished by the late Parker Cramer on August 5, 1931, when he flew a Bellanca plane, provided with pontoons and propelled by a Packard-Diesel engine, from Holstensborg on the west coast and landed at Angmagssalik. The next crossing was by Wolfgang von Gronau in a southwesterly direction from Scoresby Sound to Sukkertoppen on August 15 of the same year.

GEOLOGY

In connection with the memorial volumes of 1921 there was published a geological map of Greenland on a scale of 1 : 10,000,000 (Plate II of Atlas), which indicated that the greater part of the continent is a complex of crystalline rocks of pre-Cambrian age — gneisses, schists, and intrusive igneous rocks of both acid and basic types — a part of the Canadian shield. This relates wholly to the ribbons of coast land, since all else is buried under the ice-cap. On the west coast between latitudes 69° and 73° and on the east coast between latitudes 68° and 75° this map shows sheets of basalt; and on the north coast throughout and on the east coast generally within the area to the northward of Scoresby Sound sedimentary rocks of unknown age are represented. At the extreme south of Greenland occurs a most interesting series of highly alkaline igneous rocks, described among others by Ussing (Böggild, 1928), and having closest affinities with the alkaline igneous rocks of southern Norway. This was the status in 1921.

Since the centenary an immense amount of geological work has been done in Greenland, quite largely by that indefatigable explorer-geologist, Dr. Lauge Koch, who has with keen insight gone to the heart of the major geological problems. His work has

Map 36. Zones of the north coast of Greenland (after Lauge Koch)

dealt mainly with the sediments of the difficultly accessible north and east coasts.

In 1916, while cartographer and geologist of the Second Thule Expedition, Koch had discovered Paleozoic fossils in the sedimentary rocks of southern Washington Land, and on his own later expeditions to north Greenland he devoted much of his attention

to collecting fossils and working out the stratigraphy and structure of this coastal region.

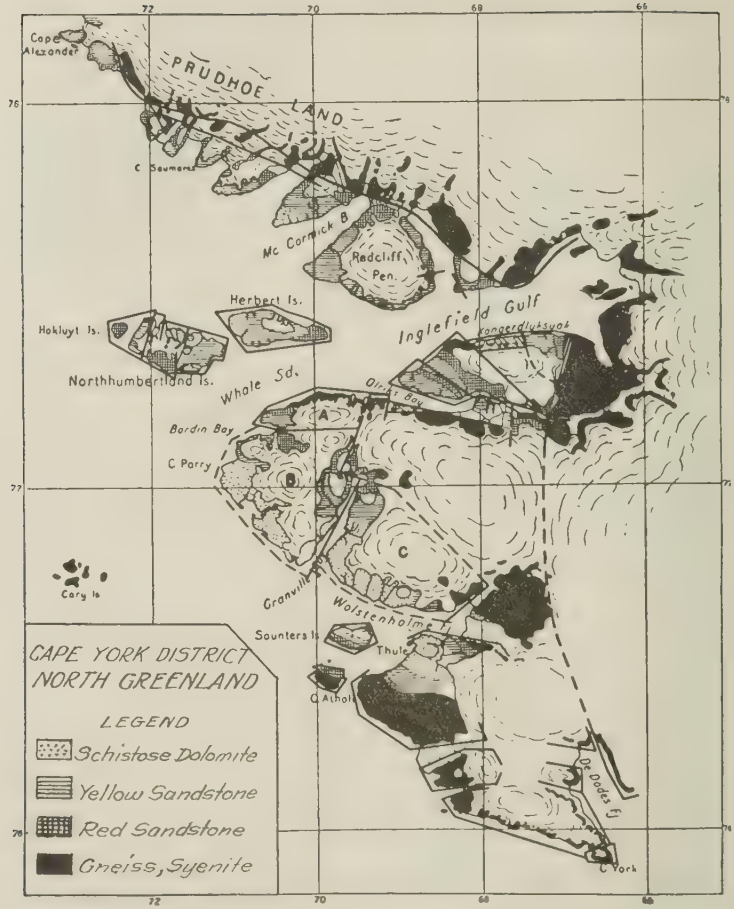
Koch found that the basement of pre-Cambrian crystalline rocks ended rather sharply on a northern boundary extending from Etah on the west near latitude 78° to near the head of Denmark Harbor on the east near latitude 80° 30′. To the northward of this boundary is a low plateau of Algonkian and Paleozoic sediments which includes Cambrian, Ordovician, Silurian, and Carboniferous rocks. The strata have not been disturbed from their original positions and are unaffected by faults. The extensive fossil collections have been described by Troedsson (Troedsson, 1926).

On the northern border of the plateau of sediments with relatively rugged topography there occur folded and metamorphosed beds which are ascribed to the period of Caledonian folding (Map 36). The distribution of the geological formations is set forth in Map 37. The Caledonian arc of the north coast shows affinities with the Caledonian arc (Map 39) of the northwest coast of Scandinavia (L. Koch, 1923*a*, 1923*b*, 1925*b*). Along the west of these zones in the Cape York region is found a zone of complex faulting (Map 38) quite in contrast with the undisturbed character of the two northern zones which it borders (L. Koch, 1926*a*). In later expeditions Koch has studied the belt of sediments of the east coast (L. Koch, 1923*b*, 1929*b*, 1929*c*, 1930) and found there a somewhat similar much-folded arc of Paleozoic sediments which strikes roughly with the east coast, as the northern arc does with the north coast. These two Greenland mountain arcs are apparently joined in a vertex near the northeast angle of Greenland (Map 39).

Wordie, in command of the Cambridge University Greenland Expeditions of 1926 and 1929, found the overthrust folds of the eastern arc pushed westward over the pre-Cambrian rocks of the main basement series (Wordie, 1927, p. 252). Backlund has studied the structures of the folded arc within the area north of Franz Joseph Fjord and supplied colored sections with the surfaces of over-thrust indicated (Backlund, 1930, p. 225, Pls. II III). The fauna collected from the east Greenland sediments has been studied

MAP 37. Geological map of north Greenland. Scale approximately 1:9,700,000 (after Lauge Koch)

by Paulsen (Paulsen, 1927) and the fossil plants by Harris (Harris, 1926). Koch has drawn attention to the fact that the Greenland basalts strikingly resemble those of Iceland and the Faroes, and that their position corresponds to a continuation of the submarine



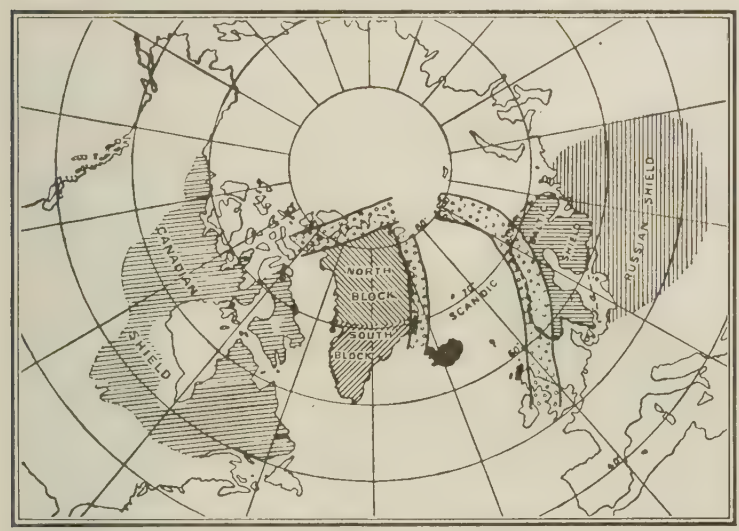
Map 38. The faulted Cape York district of northwest Greenland (after Lauge Koch)

basalt band which joins the Faroes to Iceland (Koch, 1923*b*, p. 56). This correlation is even better displayed on the new geological map of the Arctic (Holtedahl, 1930).

Dr. A. C. Seward has made an exhaustive study of the fossil

plants of the Cretaceous beds of the Nugssuak district of west Greenland (Seward, 1927).

H. K. E. Krueger, who has since perished in the Arctic, studied an area of the west coast about Disko and Umanak bays, and, confirming earlier studies by Steenstrup and others on other parts of the coast, showed that the fjords quite generally take their courses parallel to existing faults (Krueger, 1928). With associates of the



Map 39. Shields and arcs (geosynclines) about the north Atlantic Ocean (after Lauge Koch)

recent Hessian Greenland Expeditions Krueger has made petrographical studies, with accompanying rock analyses of peridotite and basalts of the Cretaceous-Tertiary formation (Krueger, 1927; Drescher and Krueger, 1927). Ball, as the result of a reconnaissance along the southwest coast, has drawn the conclusion that, with the exceptions of the valuable cryolite deposits at Ivigtut and the coal deposits on both east and west coasts farther north, Greenland is not likely to yield valuable mineral deposits.

PHYSIOGRAPHY

Ever since the transection expeditions of J. P. Koch and Alfred de Quervain in 1913, it has been known that a sag occurs in the domed surface of the ice-cap over Greenland near the latitude of Disko Bay (Map 42). Lauge Koch, by making north–south profiles of the land areas of the eastern and western coastal districts, has been able to show (L. Koch, 1923*b*) that a similar sag occurs in the glaciated surface of the rock basement near the same latitude, or about the line connecting the Disko Bay district of the west coast with the Scoresby Sound district of the east coast (Map 40). It is along this transverse zone that the Tertiary basaltic lava flows are found. To the southward and to the northward of this transectional zone the ice-cap appears to have separate domes which merge over the depression (Koch, 1923*b*, 1924).

The physiography of Greenland has been discussed in separate coastal sections: that of north Greenland by Koch (Lauge Koch, 1928*a*); that of the east coast by Storgaard (Storgaard, 1928); and that of west Greenland by Birket-Smith (Birket-Smith, 1928).

The geological units in north Greenland already described (p. 374) have largely determined the physiographic development there. The outer zone of Caledonian folding is characterized by Alpine topography, best illustrated by the northern half of Peary Land, whereas the undisturbed sedimentary strata at its back present only a monotonous plateau.

In east Greenland there are within the ice-free land zone large plateau areas over basalt flows and smaller plateau areas above the unfolded sediments, as on the north coast. The remaining portion of the district is distinctly mountainous, even Alpine, and all, with the exception of the tops of some of the highest peaks, has been sculptured under a former extension of the inland-ice from the interior. It thus presents the convexly rounded forms (*roches moutonnées, Rundhocker*) and in addition, where outlets from the interior and detached mountain glaciers have operated since the retirement of the main ice-front, comb ridges, horns, U-shaped valleys, fjords, and even cirques, have formed (Storgaard, 1928). Wordie has prepared maps and beautiful photographs which

MAP 40. Profiles along the east and west coasts of Greenland, which display a sag of the rock basement (after Lauge Koch)

display this topography in the Franz Joseph Fjord region (Wordie, 1930*a*). Alwin Pedersen also has supplied other examples from the south, particularly of Scoresby Sound (Pedersen, 1930). Watkins has shown (Brit. Exped., 1931) not only the Alpine characters, but the very strong relief of the coast land all about the Sermilikfjord of the Angmagssalik district, and near the route of his sledge party under Scott while traveling from Angmagssalik to Ivigtut in June and July, 1931.

Lauge Koch and Backlund have both supplied evidence from proved faults that at least many of the great fjords of the east coast have been given their directions by displacements or by earth fractures. Such a view, suggested by any careful inspection of the map of Greenland, has been often expressed by early investigators, but usually without proof. The fault directions chiefly noted by Koch are E.–W. and N.–S., those by Backlund E.–W., ENE.–WSW., and ESE.–WNW. (Backlund, 1930).

The west coast land over the main crystalline areas in the southwest presents to the sea a high plateau once covered by an advance of the inland-ice and strongly glaciated, later to be deeply dissected by the outlet glaciers and by detached areas of mountain glaciers; so that U-shaped valleys, comb ridges, and many deep cirques are prominent features of the landscape. A large and general subsidence of the coast-land has sufficed to submerge in many places the floors of the cirques. A subsequent uplift has produced strongly developed coastal terraces running up several hundred feet and always best preserved at the heads of the fjords (Hobbs, 1927).

The pattern of the fjords is one mainly determined by the fracture system within the rocks, of which a relatively small number of directions exercise control. This has been shown by Steenstrup, by the writer (Hobbs, 1927), by Krueger (Krueger, 1928), and by R. L. Belknap in a monograph on the physiography of the Holstensborg district of Greenland to be published in the *Reports of the Greenland Expeditions of the University of Michigan.*

As on the east coast, so here in the west the plateau is everywhere glaciated, though an excessively rapid frost weathering has effaced the polish and scorings from all but the better protected places in the bottoms of the fjord valleys. On the tops of the pla-

teau remnants of glacial boulders are perched in great numbers as mute witnesses to the former expansion of the inland-ice, and the U-sectioned fjords show the work of the outlet tongues after the main ice-front had retired.

From the sea in the southwest Greenland country the coast rises in a great staircase, the steps of which are orographic blocks, each with much the same leveled and glaciated upper surface. The lowest of these steps is composed from a swarm of low islets and reefs which form a *skaergaard* or "skerry fence," at the back of which rises an assemblage of larger islands which push up a few hundred feet from the sea. Then on precipitous slopes rises the third step several times as high as the second. Within the Holstensborg district the height of this coastal plateau fifty miles back from the sea averages about 1,700 feet, but it in turn abruptly gives place to a hinterland of low rounded hills, first described by Nordenskjöld,[5] which the writer found to be explained by a second advance of the inland-ice. The average altitude of the hilly hinterland is from one half to two thirds of that of the dissected plateau at its front (Hobbs, 1927).

Peculiar to this hinterland are certain scars of cirques found in connection with isolated areas of mountain glaciers left behind by the continental glacier in its earlier retreat, with their cirque scars largely eroded away during the readvance of the ice.

The basalt flows of the Disko and Umanak bays afford flat plateau surfaces quite different from the deeply dissected plateaus of the basement of crystalline rocks.

GLACIOLOGY

The glaciology of Greenland may be conveniently discussed for: (*a*) the main body or carapace of ice; (*b*) the marginal glaciers which serve as outlets to the parent glacier; and (*c*) detached areas of true ice-cap and mountain glaciers.

Though the transection of Greenland in its widest section was accomplished by J. P. Koch and A. Wegener in 1913 and a valuable

[5] Nordenskjöld, Otto, "Einige Züge der physischen Geographie und der Entwickelungsgeschichte Süd-Grönlands," *Geog. Zeitschr.*, 20 (1914) : 425–441; 505–524; 628–641, pls. 9–10.

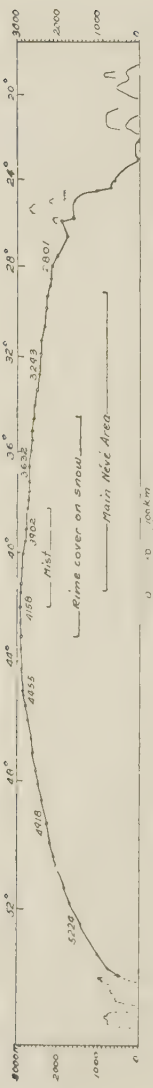


FIG. 15. Profile of the Greenland ice-cap along the route of J. P. Koch in 1913. Vertical scale fifty times the horizontal (after J. P. Koch and A. Wegener)

narrative with much scientific data was brought out in 1919,[6] the technical report was delayed for seventeen years and first appeared in 1930 (Koch and Wegener, 1930).

One of the most important results is concerned with the profile of the ice-cap along the route of the expedition. This section as corrected by Koch with fifty-fold exaggeration of the vertical scale is reproduced in Figure 15. The track of the journey appears on Map 41. The crest of the dome on this section is well to the west of the medial line of the continent, whereas the divide on Nansen's section lay well to the east and that on De Quervain's section near the medial line (Map 41). The divide on Koch's section is at an altitude of 10,463 feet, much the highest point thus far discovered upon the ice. The Swiss Expedition's section, made in the same year under the late Alfred de Quervain, was from near Jakobshavn (Quervainshavn) on the west coast to Angmagssalik on the east coast, and the final report, mainly in the German language, appeared in 1920.[7] In the French language this important report has now been issued in the *Meddelelser* (De Quervain and Mercanton, 1925). At Wegener's central station of Eismitte eastward from Umanak the altitude was found to

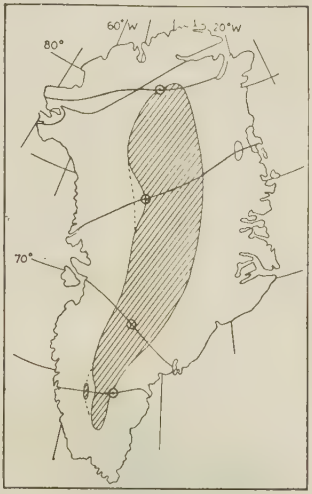
[6] Koch, J. P., *Durch die weisse Wüste, Die dänische Forschungsreise quer durch Nordgrönland 1912–13.* Deutsche Ausgabe besorgt von Prof. Dr. Alfred Wegener, 248 pages, 158 text figs., 2 maps. Springer, Berlin, 1919.

[7] De Quervain, A., and Mercanton, P. L., *Ergebnisse der schweizerischen Grönland Expedition,* Denkschr. d. schweiz. Naturf. Gesell., 53 (1920) : xx and 492, Pls. 10.

be 9,840 feet (Berlin Geog. Soc., 1932). Since the crest reached by De Quervain was at an elevation of 8,197 feet and that of Nansen farther to the south at 8,932 feet, it is clear that a depression of the ice surface must occur in the neighborhood of De Quervain's section.

Two profiles across the marginal portion of the inland-ice have been made by Wegener in his preliminary Greenland Expedition of 1929 (Wegener, 1930*a*), which indicate that north of De Quervain's route near the west coast the slopes rise rapidly. Wegener's longer section was directed to the east, the other to the northeast (Fig.16).

In June and July, 1931, J. M. Scott, with two companions of the British Arctic Air Route Expedition, crossed the inland-ice from the base near Angmagssalik southwestward inside the mountain belt to the latitude of Umivik Bay and thence direct to Ivigtut. After they had crossed Nansen's route a crest of the ice was passed, which from uncorrected observations was "well over 9,000 feet," thus confirming the view already arrived at that a southern dome of the ice surface is in this general region. Cramer in his flight over the ice-cap on August 5, 1931, from Holstensborg to Angmagssalik to clear the ice easily flew at an altitude of 9,600 feet. Koch's revised contour map of Greenland is reproduced in Map 42 (Lauge Koch, 1930).



Map 41. Transection routes of explorers, and cold central area of Greenland. From top to bottom, routes of Rasmussen, J. P. Koch, De Quervain, and Nansen, respectively. Divides are shown by small circles (after J. P. Koch and A. Wegener)

That the inland-ice formerly extended over most of the now ice-free land on its borders has been made clear (Hobbs, 1927; L. Koch, 1928*b*). With the exception of the tops of some of the

highest peaks, which appear to have protruded through the larger glacier as nunataks, the only considerable area of Greenland not covered was the northern half of Peary Land (L. Koch, 1923*b*), where a marginal moraine has been found (Map 43) south of the high Alpine region (L. Koch, 1928*b*).

As regards recent changes in position of the ice-front, Lauge Koch has found that in north Greenland the coast once stood 210 meters (689 feet) higher than now, and that since the culmination

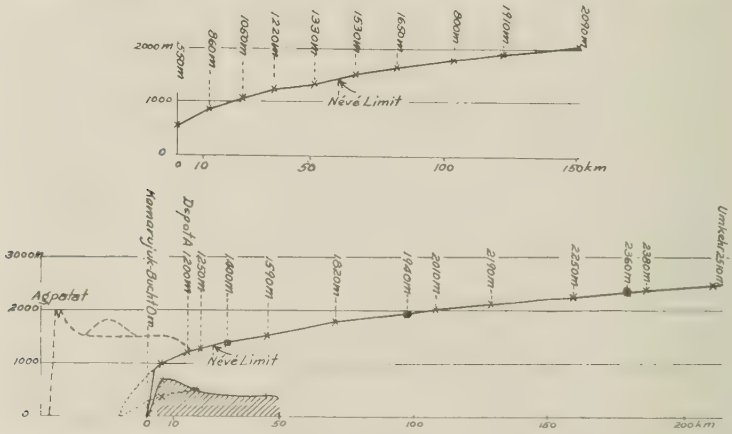
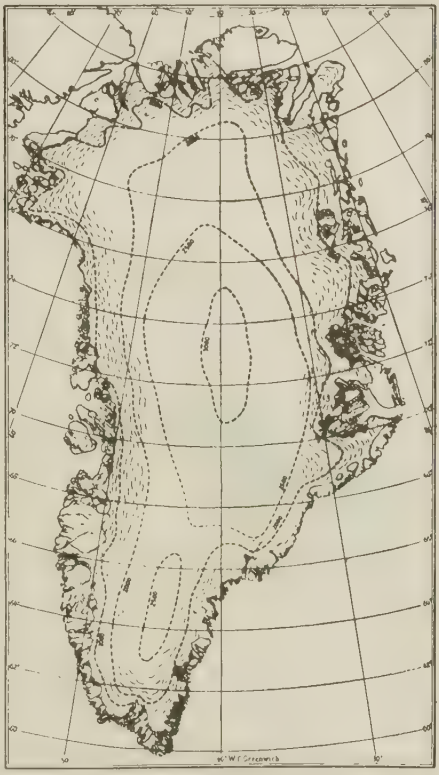


FIG. 16. Two profiles across the marginal zone of the inland-ice of the Greenland west coast, in the Umanak–Disko Bay region, with part profile of the rock basement (after A. Wegener)

of the subsidence none of the glaciers near the 210-meter level have advanced (L. Koch, 1928*b*). Within the Cape York district most of the glacier fronts appear to be stationary.

On the west coast Wegener has made important measurements in the Disko-Umanak district and found that, with the exception of the Great and Small Karajak glaciers near latitude 71°, whose fronts are practically where they were forty years ago, the glacier fronts have retired by distances which vary from about one-half kilometer in the case of the Sermilik glacier since 1891, to three and eight-tenths kilometers in the case of the Kome outlet since 1893 (Wegener, 1930*a*). William S. Carlson, in charge of the

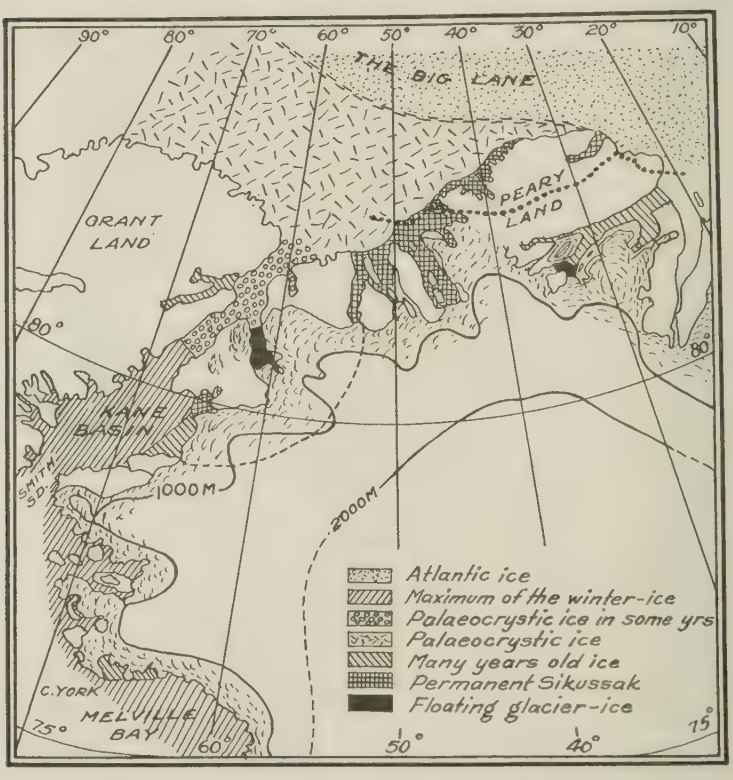
Northern Party of the Fourth Greenland Expedition of the University of Michigan, has in the summer of 1931 remeasured the front of the north arm of the Cornell Glacier near latitude 74°, which was measured by Tarr's party thirty-four years before, and found a maximum retirement of about 2,500 feet, with an average of about 1,500 feet. The Upernivik glacier he found to have retired since 1886 (Ryder) a maximum of 5,000 feet, with average 3,500 feet. Giesecke's glacier within the same period retired a maximum distance of 3,200 feet, with average of about 2,000 feet. He has photographed the fronts of all glacier outlets of the west coast from the latitude of Upernivik to the Devil's Thumb (latitude 72° 30′ to 74° 45′).



Map 42. Revised contour sketch map of the Greenland ice-cap (after Lauge Koch, 1930)

The rate of the flow of the ice within glacier outlets of Greenland has been measured in the past with results surprisingly large, in one instance 75 feet per day. Few have attempted the far more difficult task of measuring the rate in the inland-ice itself. De Quervain, however, by use of bamboo poles set at the corners of a network of nearly equilateral triangles which extended two kilometers

in from the ice edge, discovered that within this distance the rate varied but little, the range being from one to two feet per day (De Quervain and Mercanton, 1925). The ablation indicated for



Map 43. Form of ice-cap in north Greenland and conditions surrounding it (after Lauge Koch)

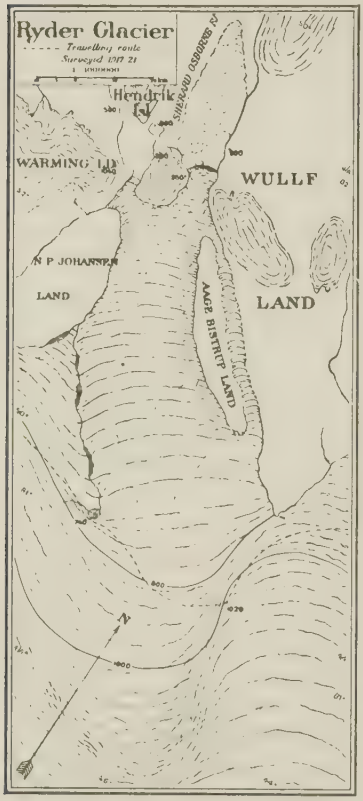
a period of thirty-nine days during the summer of 1912 amounted in some instances to as much as 1.2 meters. Carlson measured the movement in the Upernivik glacier over a period of fifteen days, with maximum movement 67 feet per day, and the average movement at different points of the front varying from 2 to 59 feet.

There has been much speculation about the level of the rock basement beneath the Greenland inland-ice, but until 1929, when echo soundings were made in connection with the Preliminary German Expedition of Dr. Wegener, nothing was known. Dr. Sorge applied the seismic method perfected by H. Mothes [8] in measurement of the thickness of Alpine glaciers (Wegener, 1930*a*; Sorge, 1930). Wegener's measurements were made along his main sledge route eastward from the Kamarujuk glacier near latitude 71°; and the derived profile extended to a point nearly fifty kilometers from the ice edge, where the thickness was found to be 1,200 meters (Fig. 16, p. 384). Though the ice surface rose steeply along this section, the rock bed was depressed into the form of a saucer. These soundings were extended on the main expedition of 1931–32 (Else Wegener, 1932, and Berlin Geog. Soc., 1932). Like the earlier data these seem to indicate considerable irregularity of the rock floor, though the saucer form seems to continue to the end of the profile at Eismitte. At this place, which is at an altitude of about 3,000 meters, the rock floor was found to be between 300 and 500 meters above the sea. The soundings further indicated the depth of *névé* upon the glacier surface, this contact being relatively definite in the outer portions, but much less so below the interior station.

The interior of the "Great Ice" of Greenland offers little save monotony of aspect once the marginal zone has been left behind — a vast plain with grades so slight that a theodolite is necessary to make them known; but as one approaches the margin from the interior the grades increase at an accelerated rate. Lauge Koch has sketched the contours of 2,000 and 1,000 meters on this surface in north Greenland; the former, far back from the margin and with strong embayments above each of the principal outlets into the fjords (L. Koch, 1928*b*). Peary described these amphitheaters as "basins of exudation" and von Drygalski mapped one main outlet above the Umanak fjord. Lauge Koch has mapped the amphitheaters at the heads of the Petermann and Ryder glaciers of north Greenland (Map 44). These are a

[8] Mothes, H., "Seismische Dickenmessungen von Gletschereis," *Zeitschr. f. Geophysik*, 3, Heft 4, pp. 121–134.

universal feature wherever the inland-ice exudes through outlets of the rock basement. De Quervain prepared a map of the inland-ice margin on Petersens Bay on the Sermilik fjord near Angmagssalik (De Quervain and Mercanton, 1925), where the amphitheaters are directly at the shore (Map 45).



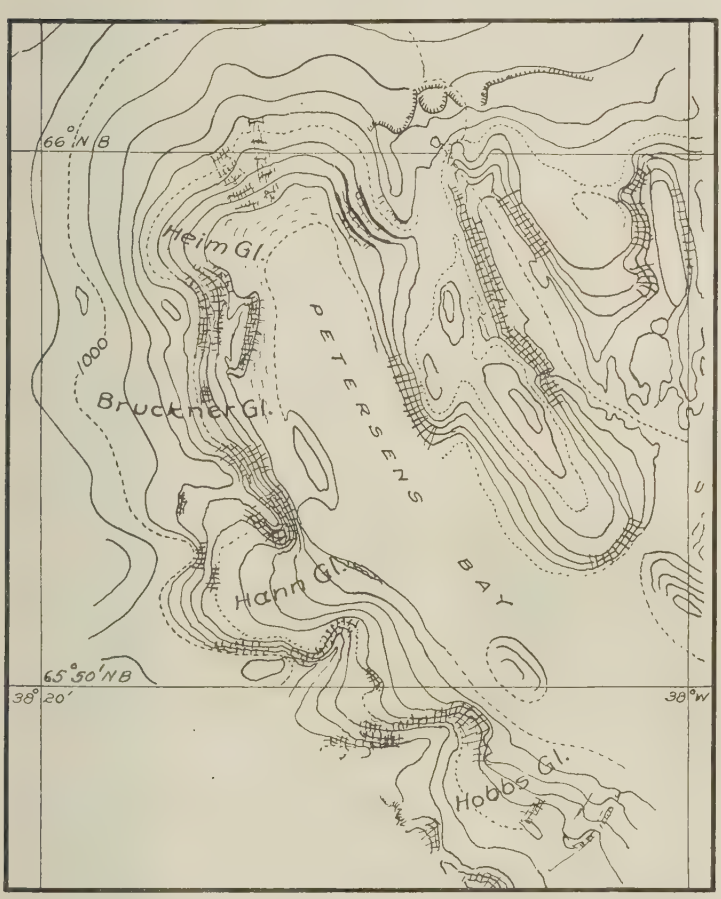
MAP 44. Ryder Glacier of north Greenland, with its floating tongue (after Lauge Koch)

In northwest Greenland on Melville Bay from the Devil's Thumb to Cape York the inland-ice in similar manner comes close to the sea over a stretch of 250 miles of coast, though divided by projecting rock into seventy separate passages within which the glaciers are given names.

On the northeast coast between latitudes 78° and 79° two large outlets discharge so much ice that it accumulates in the Jökelbugten behind a line of rocky islets which hem in the bay. This ice was described by J. P. Koch and A. Wegener [9] as the "floating inland-ice of Glacier Bay," and it supplies the nearest parallel in the Arctic today with the shelf-ice of the Antarctic. L. Koch has now described this floating ice under the name "confluent ice" (Map 46).

Some of the glacier outlets of the north coast end in tongues which float upon the fjords, separated near their fronts from the

[9] Koch, J. P., and Wegener, A., "Die glaciologischen Beobachtungen der Dänemark-Expedition," *Med. om Grönl.*, 46 (1912) : 7–16.



Map 45. Petersens Bay and the edge of the inland-ice (after De Quervain and Mercanton)

fjord walls by the sea ice (Lauge Koch, 1928*b*, p. 346). Examples are the Petermann and Ryder glaciers (Map 44, p. 388). The essential difference between these floating tongues and those of the Antarctic Koch illustrates by Figure 17. Ice tongues of the

Antarctic type, which push out beyond the coast line, have Greenland representatives in Petermann and Sherard Osborne fjords, and beginnings of such tongues are at the fronts of the Jungenen and Academy glaciers. Since in northern Greenland icebergs cannot issue from the fjords, a gradual transition sometimes occurs from the crevassed glacier front to closely packed groups of bergs.

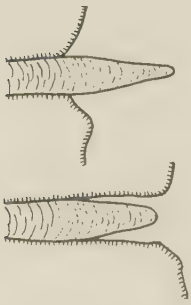
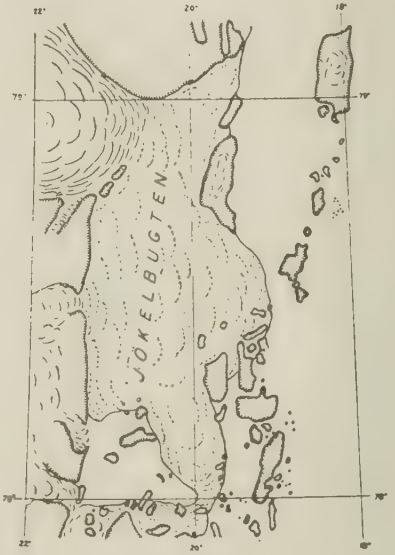


Fig. 17. Ice tongues afloat: above, Antarctic type; below, Greenland type (after Lauge Koch)

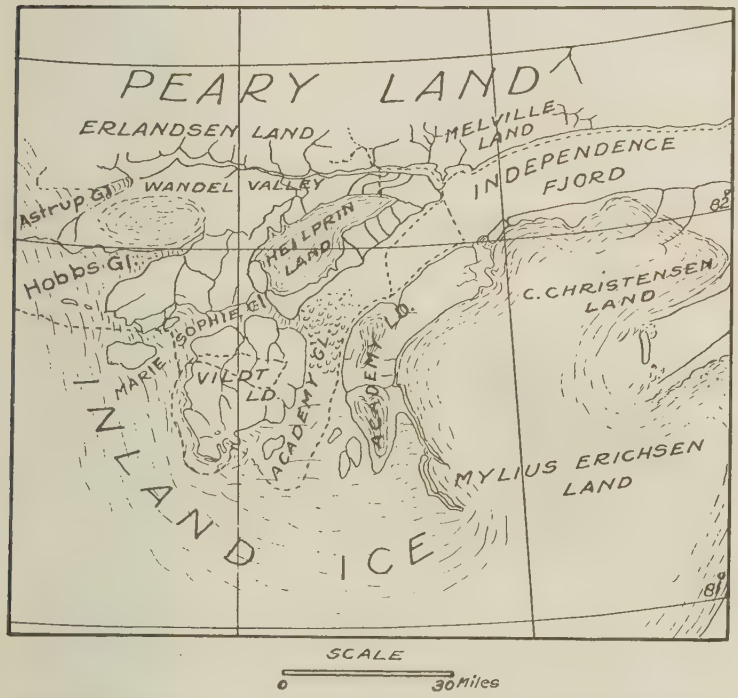


Map 46. The confluent ice of Jökelbugten, northeast Greenland (after Lauge Koch)

A district where outlet glaciers end upon the land is the area north of the head of Independence Bay. This is the most northern and most inaccessible group of glaciers that is known, and one that occupies a controversial area which has been mapped most recently by Lauge Koch. This group is shown in Map 47.

Either wholly or partly detached from the inland-ice are what Lauge Koch has described by Priestley's term, "highland ice" — local ice-caps. Such glaciers, just separating from inland-ice, are

found well developed in the Cape York district (Map 48). Similar small ice-caps appear upon Map 47, and they are found in many other places outside the inland-ice where the land rises sufficiently for them to survive in the existing climate. To in-



Map 47. Group of glacier outlets near the head of Independence Bay, Peary Land (after Lauge Koch, 1927)

dicate how the waning of the glacier remnants of a small ice-cap persists on the basalt plateau of Disko Island, there are found on the west side of this plateau outlets from this ice-cap which have discharged over the steep sides of the plateau, but are now detached (Koch, 1928*b*, pp. 339–340) and melt chiefly at their upper

ends, as do the much larger detached slabs of ice in the Antarctic of South Victoria Land.[10]

True mountain glaciers are found well developed within certain of the coastal Alpine districts of Greenland on both the

Map 48. Glaciers of the Cape York district (after Lauge Koch)

east and west coasts. Here, in consequence, we find locally a development of cirques, comb ridges, U-shaped valleys, and other related forms.

METEOROLOGY

By reason of its auto-circulation the ice-cap of Greenland assumes very special importance in the earth's general atmospheric

[10] Taylor, Griffith, *Brit. Ant. Exped. 1910–13, The Physiography of the McMurdo Sound and Granite Harbour Region*, 1922; map on page 101.

circulation, and hence in meteorology and especially in aërometeorology. Two great polar explorers, Nansen and Peary, the former at the time of his transection of the ice-cap in 1888, and the latter through his many Greenland sledge journeys which began in 1886, reached independently the conclusion that the surface air currents blow outward from the interior at all times. The necessary deductions to be made from these observations and others which confirm them were expressed by the writer in 1911, 1912, 1915, and 1926 (Hobbs, 1926), and the circulation over continental glaciers was described under the name "glacial anticyclone" — Greenland anticyclone and Antarctic anticyclone — which are fixed in position as the northern and southern wind

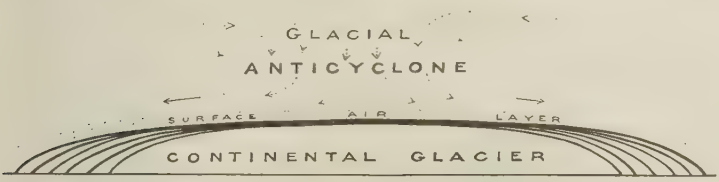


Fig. 18. Mechanism of the fixed Greenland anticyclone (after Hobbs)

poles of the earth. Summarized, these circulations are represented in Figure 18 and their part in the general circulation in Figure 19.

Every new expedition has added its testimony to the correctness of the theory of centrifugal distribution of the surface air currents, with deviation clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere. So constant and reliable is this circulation that each party that has crossed the ice-cap has battled against head winds and fierce blizzards in advancing to the divide of the section, and has then sailed out on the other side in long *étapes*.

One of the latest examples is supplied by Dr. Wegener on his two sled journeys of the Preliminary German Expedition to Greenland in 1929. From examination of the diagrams of Figure 20 it will be noted that wind was constantly from near the east or southeast (down slope with clockwise deviation), except when the wind force fell to near a dead calm (Wegener, 1930*a*).

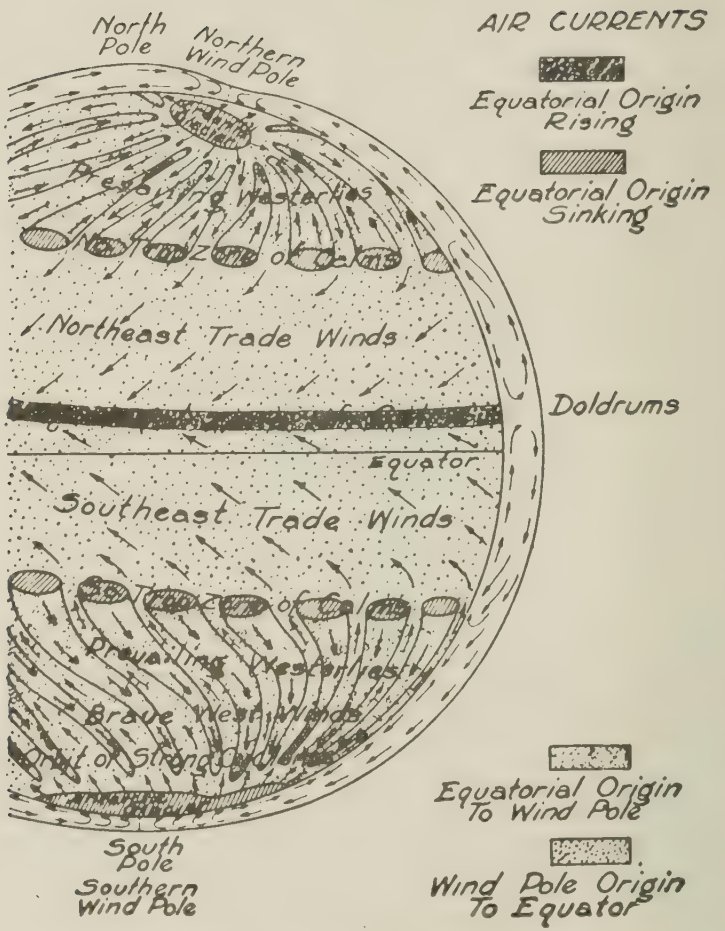


Fig. 19. The earth's general circulation, with conventionalized representation of the complex system of opposing currents in middle latitudes (after Hobbs)

The Meteorological Institute of Copenhagen maintains in Greenland meteorological stations at six coast settlements well distributed on the west, south, and east coasts, but all south of latitude 71°. At each of these stations the usual meteorological elements are regularly observed and recorded, and at each station a powerful radio sender of long wave length puts certain fundamental data regularly on the air for the use of various meteoro-

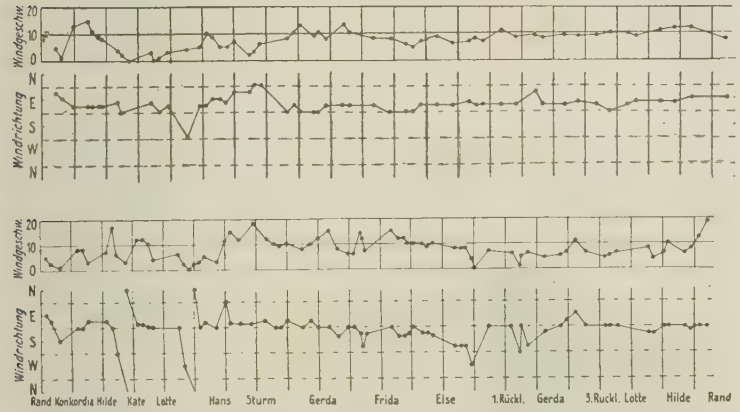


FIG. 20. Diagrams showing the direction and velocity of the wind on the journeys over the ice-cap toward the interior of Greenland in the summer of 1929. Above, hand-sled expedition in direction northeastward from Jakobshavn; below, dog-sled expedition directly eastward from the Kamarujuk Glacier (after A. Wegener)

logical and forecasting services. These stations are at Godhavn, Godthaab, Ivigtut, Julianehaab, Angmagssalik, and Scoresby Sound. In addition, the Norwegians maintain a station at Mygbukta on the east coast, near latitude 73°, where there is a short-wave radio station. The location of these stations is indicated on Map 49.

In addition to the stations provided with radio, meteorological observations are regularly made at a number of other stations, such as Nanortolik, Igaliko, Sagdlit, Kornok, Holstensborg, Karsut, and Upernivik, by an observer who is usually an intelli-

Map 49. Meteorological stations of Greenland

gent Greenlander. These observations are published annually at Copenhagen in the *Meteorologisk Aarbog* of the Meteorological Institute. The Danish service has not as yet employed aërological methods, and since the Greenland stations are generally within the mouths of steep-walled fjords their wind and temperature data have little value.

Upper-air methods were first introduced in Greenland on the Danish Northeast Greenland Expedition of 1907–8 by Alfred Wegener, the meteorologist of the expedition, who made use of kites and captive balloons; and though the ascents did not go higher than 2,000 to 3,000 meters, the results were of the greatest value in showing that above the local winds of the fjords the winds blowing off the ice dominated up to the highest levels reached. Until that time all studies of winds over any considerable period had been made on the west coast, and since these always came from easterly quadrants it had been assumed that they had blown *across* the ice-cap.

The Swiss Expeditions of 1909 and 1912–13 made special use of pilot balloons, which were sent up from several stations of southwest Greenland, including Godhavn (85 ascensions), Jakobshavn (6), Quervainshavn (7), and Holstensborg (22). These balloons were followed to an average altitude of 6,000 meters, with several which reached exceptional heights.

In the summer of 1926 the First University of Michigan Greenland Expedition established a base at Camp Michigan near the head of the Maligiakfjord about forty miles east of the coast settlement of Holstensborg. Here during the months of July, August, and September some 90 pilot balloon ascensions were carried out by Mr. S. P. Fergusson, the aërologist of the expedition (Hobbs, 1931*b*, pp. 49–67). The location proved to be less satisfactory than had been hoped, and the Second Expedition of 1927 established a new base with an aërological station on Mount Evans, near the head of the Söndre Strömfjord, one hundred and twenty miles from the sea and only twenty-five miles distant from the margin of the inland-ice. This station, with its clear skies, proved admirably suited for aërological work. It was maintained in continuous operation for two years, during which

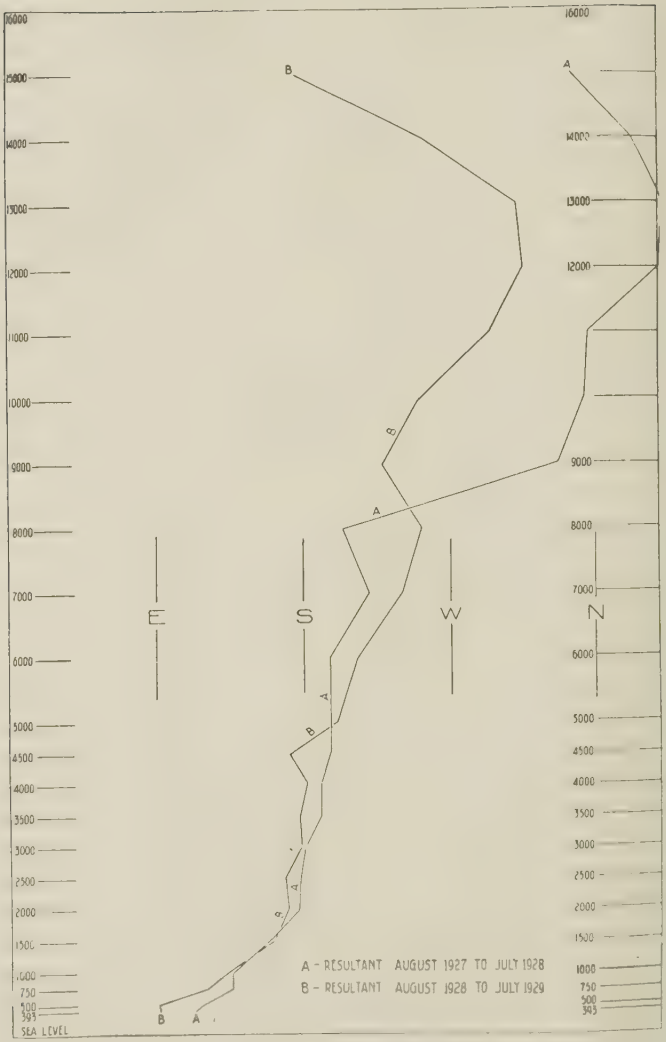


FIG. 21. Average wind directions over Mount Evans, Greenland, for successive years (after Hobbs)

time 776 pilot balloon ascents were carried out by Clarence R. Kallquist, William S. Carlson, and Leonard R. Schneider, the successive aërologists in charge (Hobbs, 1931*b*, pp. 71–239). The results showed that all strong surface winds blew off the ice, and that these extended up to a level which varied with the season, being highest during the winter when the strophs were stronger. At levels varying generally from 2,000 meters as a minimum to 6,000 or even 8,000 meters or more, the outflowing air was replaced above by inblowing currents. The averages for two suc-

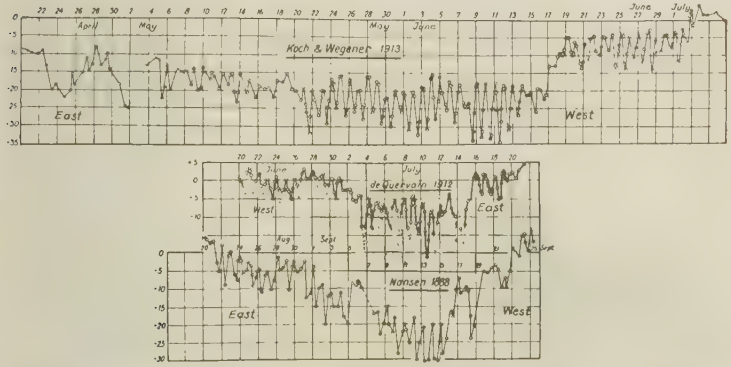


Fig. 22. Daily air temperatures measured on transections of the Greenland ice-cap, by Koch and Wegener, De Quervain and Nansen (after J. P. Koch and A. Wegener, 1930)

cessive years are given in Figure 21. Pilot balloons sent up in the summer of 1927 at the Norwegian station of Mygbukta on the east coast were in part simultaneous with those sent up at Mount Evans. These ascensions, 35 in number, if we ignore the local currents below the level of 1,000 meters, indicated reversed directions, as was to be expected from the mechanism of the glacial anticyclone. The surface winds blow off the ice here from the northwesterly quadrant (Hobbs, 1931*b*, pp. 32–37).

The report of Koch and Wegener on the scientific results of the Danish Expedition of 1912–13 affords most important data for the study of the conditions over the interior of the ice-cap.

Comparisons of the daily air temperature measurements made during the transections of Greenland by Nansen, De Quervain, and Koch show that in each case the sled parties passed suddenly from areas of moderate summer air temperatures on the flanks of the ice-dome into a central area of intense cold (Figure 22). The boundaries of this central area of cold and calm, as determined from the three transections, are given in Map 41, p. 383, and Koch and Wegener's representation of the glacial anticyclone appears in Figure 23.

In 1930 31, for the first time, something approaching coördination in upper-air studies from definite stations of Greenland was attempted for the period of a year (Map 50). Following upon his preliminary expedition of 1929, Dr. Alfred Wegener went to Greenland in 1930 in command of one of the largest and, for scientific purposes, best organized expeditions which have ever gone to the polar regions. His plans contemplated setting up three stations near the latitude of 71°, one on the ice-cap itself though near to its western margin, one on the east coast near but not on the ice-cap, and one near the medial line of the ice-cap between the other two. This extremely difficult program was carried out. The eastern station had to be managed as a separate expedition under Dr. Kopp. The central station was reached from the west coast, and the arduous and hazardous problem of providing its supplies of equipment, food, and fuel was solved by dog-sled caravans, and for a part of the distance by motor sleds from the west coast. This central station was in charge of Dr. Johannes Georgi, veteran aërologist of the Deutsche Seewarte at Hamburg. Despite the many hardships and disasters, which included the loss of the heroic leader, the central station was maintained for a full year, with scientific results which have now been published in narrative and in summarized technical reports (pp. 410–411).

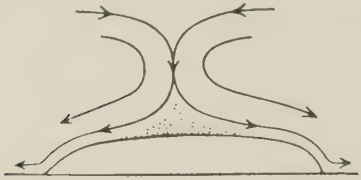
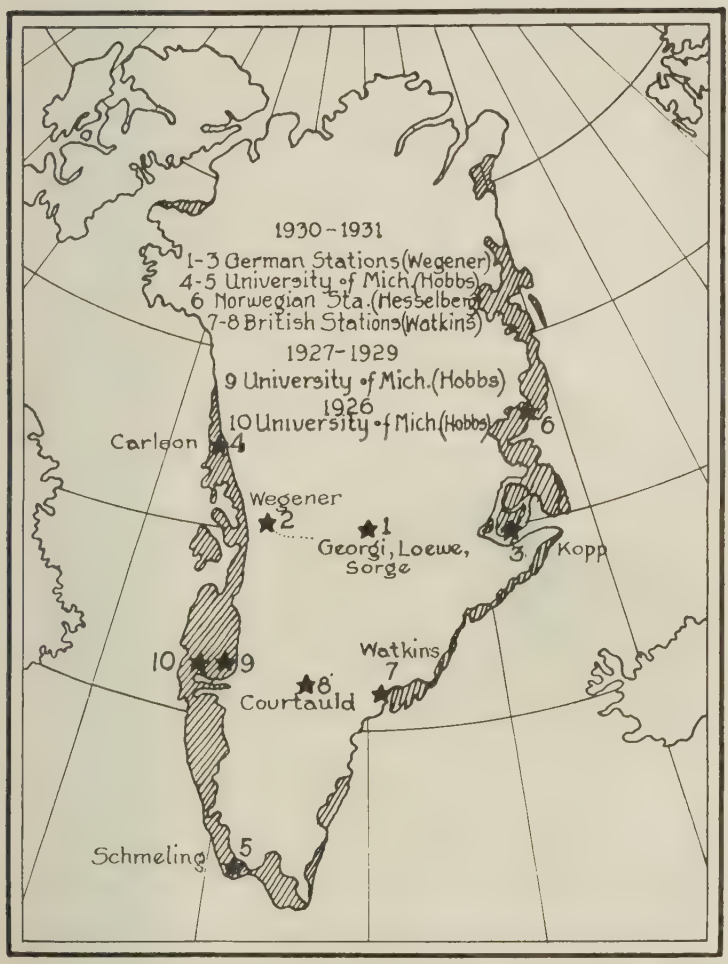


Fig. 23. Mechanism of the glacial anticyclone (after J. P. Koch and A. Wegener, 1930)



Map 50. Positions of aërological or meteorological stations actually set up in Greenland in 1930–31

Farther south and in about the latitude of Mount Evans were the two stations of the British Arctic Air Route Expedition under command of H. G. Watkins. These stations have had meteorological but, unfortunately, not aërological equipment. Under conditions similar to those encountered by Dr. Georgi and his two companions at the German central station of Eismitte, Augustine Courtauld of the British Expedition spent nearly seven winter months entirely alone at their central ice-cap station northwest of Angmagssalik.

The University of Michigan maintained in 1930–31 two aërological stations on the west coast, the northern one at Camp Scott on a small island two miles distant from the ice margin and to the eastward of Upernivik near latitude 72° 45′ (Hobbs, 1931*c*). This station, in charge of William S. Carlson, assisted by Max Demorest, was maintained for eight months (Aug. 28, 1930, to April 27, 1931), during which time 238 pilot balloon ascensions were carried out. At the south station in the mining settlement of Ivigtut, Evans S. Schmeling carried out 177 pilot balloon ascensions and 94 cloud-altitude observations (Sept. 1, 1930, to Sept. 1, 1931).

In the Second International Polar Year, 1932–33, it is expected that several aërological stations will be maintained in Greenland and in positions not before occupied, notably at Angmagssalik on the east coast and Cape York in the northwest.

University of Michigan

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GEOLOGIC STRUCTURE OF A SMALL AREA WEST OF MILL SPRINGS, KENTUCKY *

THOMAS S. KNAPP AND JOSEPH C. TWINEM

INTRODUCTION

THIS paper describes the geological structure of the rocks in a small area in Wayne, Pulaski, and Russell counties a few miles west of Mill Springs, Wayne County, Kentucky. The area, which is shown in the north-central part of the Monticello topographic sheet of the United States Geological Survey, is rectangular. Its length in a north-south direction is about 6 miles and its width about $3\frac{1}{2}$ miles (see Map 51).

The study of the structural geology of the area was suggested to the writers by Professor G. M. Ehlers of the Department of Geology of the University of Michigan, to whom they are greatly indebted for aid in planning the field work and in preparing the manuscript of this paper. They are also under obligation to Mr. Robert Hefferan, a student at the University of Michigan, for assistance in the field.

PHYSIOGRAPHY OF AREA

The area is in the Highland Rim section of the Interior Low Plateaus. The major topographic features are the result of erosion and deposition by the Cumberland River during past and present geologic times. Three distinct topographic levels have resulted from the work of this river. The lowest is represented by a river flat, the "river bottom" of the local residents, the average elevation of which is about 640 feet above sea level. In summer the Cumberland River is usually about 50 feet lower than the river flat; in the winter season it often covers the flat. A higher topographic level, the Highland Rim Plateau, has an elevation of from 900 to 950 feet. This level was produced by

* A contribution from the Geological and Geographical Field Station of the University of Michigan at Mill Springs, Kentucky.

planation of the river during late Tertiary or early Pleistocene time. The surface of the plateau is modified by sink holes, which are very numerous in the southeastern part of the area, and by stream erosion, which has been especially active north of the river. The highest topographic level is the Cumberland Plateau, the average elevation of which is about 1,300 feet in adjacent areas.

A small outlier of this plateau, the summit of which has been lowered by erosion to an elevation of 1,100 feet, is close to the eastern boundary of the area about $1\frac{3}{4}$ miles northeast of Rankin (see Map 51).

STRATIGRAPHY OF AREA

The area is on the southeast limb of a saddle connecting the Jessamine and Nashville domes of the Cincinnati Geanticline. Owing to its position on the southeast side of the saddle, the regional dip is to the southeast. Except where local reversals of dip occur, successively younger beds are encountered as one proceeds southeastward across the area.

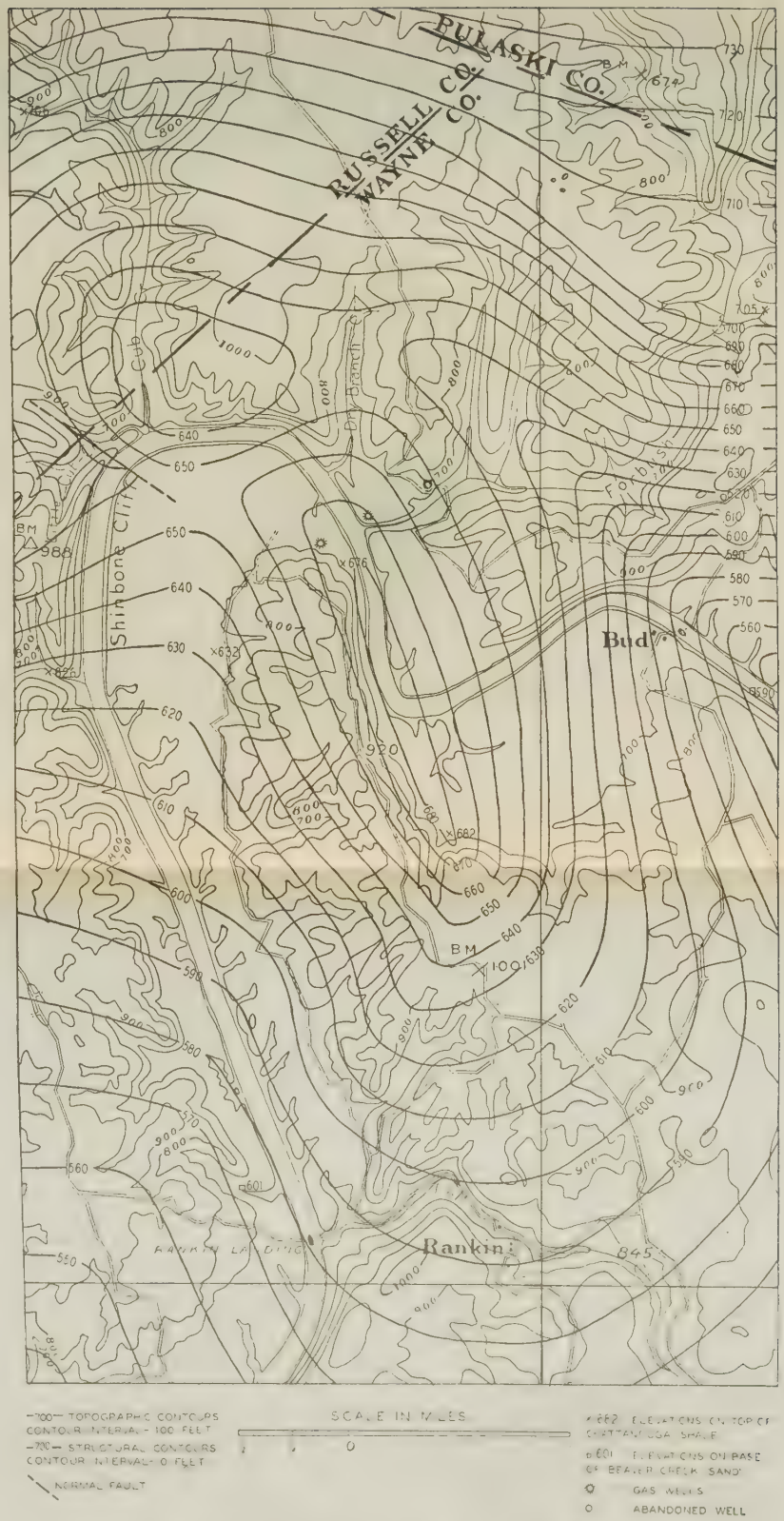
Rocks of Mississippian age compose most of the stratigraphic section, but older beds of Ordovician and Silurian age outcrop at Shinbone Cliff and at many places in the tributary streams on the north side of the Cumberland River.

Description of formations

Richmond formation. — The Richmond formation, which is included in the Ordovician system by most geologists and in the Silurian system by a few, is the oldest formation exposed. It outcrops at Shinbone Cliff, in Little Cub Creek, and in Forbush Creek. The lower half consists of a thin and even-bedded, ripple-marked and sun-cracked, greenish gray limestone; the upper part, of uneven and thicker-bedded buff-gray limestone, which has a nodular appearance on weathered surfaces. According to Donald C. MacLachlan,[1] 46 feet of Richmond is exposed at Shinbone Cliff.

Brassfield formation. — The Brassfield formation of lower

[1] MacLachlan, D. C., "Geologic Structure of a Small Area in Wayne, Pulaski and Russell Counties, Kentucky," *Pap. Mich. Acad. Sci., Arts and Letters*, 8 (1927) : 300.



Map 51. Topography and geologic structure of top of Chattanooga shale

Silurian age rests disconformably upon the Richmond. It is a massive buff to reddish gray magnesian-limestone, containing fluted cystid columnals. At Shinbone Cliff it is approximately 10 feet thick. Good exposures occur along Forbush Creek and some of its tributaries.

Crab Orchard formation. — The Crab Orchard formation of middle Silurian age rests disconformably on the Brassfield. It consists of interbedded greenish shale and greenish gray to buff limestone. Dr. Foerste[2] noted the occurrence of 17 feet at Shinbone Cliff. A small exposure is also in the bank of Cub Creek about 200 feet upstream from the Wayne-Russell county line.

During pre-Mississippian time the Richmond, Brassfield, and Crab Orchard formations were subjected to erosion. The Brassfield and Crab Orchard were entirely removed from some parts of the area, so that the Mississippian beds were deposited uncomformably on the Richmond.

Chattanooga formation. — The Chattanooga shale is the oldest Mississippian deposit in the area. It is a well-jointed, black, fissile, bituminous shale containing linguloid brachiopods and conodonts (see Pl. XXXIX, Fig. 1). A brown sandstone, 1 to 2 inches in thickness, commonly lies at the base of the formation. At a few places this sandstone has a thickness of 3 feet. At some localities the upper beds of the formation contain nodules of marcasite. A small number of cherts occur near the base along Little Cub Creek. The formation ranges in thickness from 33 to 38 feet.

New Providence formation. — The New Providence formation, which rests disconformably on the Chattanooga shale, is composed of three distinct parts. The lower part consists of a greenish gray to bluish gray shale, which weathers to a greenish gray clay (see Pl. XXXIX, Fig. 2). The basal beds of the shale contain phosphate nodules, which in some places are very numerous. The middle part of the formation is a hard, siliceous, encrinal limestone, containing irregularly shaped masses of chert arranged

[2] Foerste, Aug. F., "The Cincinnati Anticline in Southern Kentucky," *The American Geologist*, 30 (1902) : 362; *idem*, "The Silurian, Devonian, and Irvine Formations of East-Central Kentucky," *Kentucky Geol. Surv.*, Bull. 7 (1906) : 114–115.

parallel to the bedding. This limestone, known locally as the "Beaver Creek sand," is an oil- and gas-producing stratum in the Monticello-Steubenville pool a few miles southeast of the area. The upper part of the New Providence, which is lithologically similar to the lower, differs from it in being more calcareous. The thickness of the lower New Providence ranges from 23 to 50 feet; of the middle, from 3 to 7 feet; and of the upper, from 35 to 50 feet.

Overlying the New Providence in the order named are the Fort Payne, Warsaw, St. Louis, Ste. Genevieve, and Gasper formations of Mississippian age. The Pennsylvanian is represented by the Lee sandstone, which caps the tops of several outliers of the Cumberland Plateau a short distance southeast of the area. River gravels, thought to belong to the Irvine formation of late Pliocene or early Pleistocene age, occur in patches on the Highland Rim Plateau. The alluvium of the river flat may be in part of later Pleistocene as well as post-Pleistocene age.

FIELD METHODS USED IN DETERMINING STRUCTURE OF AREA

The top of the Chattanooga shale was selected as a key horizon for mapping the structure of the area. This selection was made because the shale was very little eroded prior to the deposition of the overlying New Providence shale and is lithologically distinct from overlying and underlying strata.

The elevations of the top of the Chattanooga shale and their locations were determined by the use of a telescopic alidade and plane-table.

The approximate elevation of the top of the Chattanooga shale was obtained at many places by first determining the elevation of the base of this shale or of the base of the Beaver Creek limestone. When the elevation of the base of the Chattanooga shale was used, the thickness of the shale, which ranges from 33 to 38 feet, was added to it. When the elevation of the base of the Beaver Creek limestone was used, the interval between this limestone and the top of the Chattanooga shale was

subtracted from the elevation of the base of the Beaver Creek limestone in order to obtain the elevation of the top of the Chattanooga shale. Owing to a considerable range in the thickness of the interval between the Beaver Creek limestone and the Chattanooga shale, it was necessary to make frequent measurements of this interval.

STRUCTURAL GEOLOGY OF THE AREA

The most prominent structural feature is an elongated dome located in the central part of the area (see Map 51). It has a narrow crest which extends N. 25° W. for a distance of about 1½ miles. The elevation of the highest point along the crest is about 685 feet. The closure of the dome is from 25 to 30 feet. The dome is slightly asymmetrical; the dip per mile on the east side is about 90 feet; on the west side, about 80 feet. The crest of the dome plunges to the southeast at a rate of about 80 feet per mile for the first quarter of a mile, decreasing gradually to 25 feet per mile near the southern boundary of the area. The southeast end is modified by a structural nose which curves to the southwest and disappears in the syncline on the west side of the dome. At its northwest end the dome dips northward at a rate of 50 feet per mile for a quarter of a mile and then flattens out abruptly into a structural saddle connecting the dome with a homocline occupying the northern quarter of the area. The elevation of the lowest point along the crest of this saddle is about 643 feet above sea level.

In 1927 MacLachlan [3] published a map on which he showed the dome as having a lower and flatter crest than the findings of the present writers would indicate; he also represented the elongation of the dome as extending in a north-south direction instead of in a northwest-southeast direction, as determined by the writers. The difference in the form and orientation of the dome as illustrated on MacLachlan's and the writers' maps is due to different methods of determining elevations of the top of the Chattanooga shale. MacLachlan obtained these elevations by reference to elevations given on the Monticello topographic

[3] *Op. cit.*, Figure 24.

sheet. Careful observations by the writers have demonstrated that numerous elevations on this sheet are incorrect; apparently many of the contours were plotted without an adequate number of readings. The fact that the present writers based their mapping on a larger number of more accurately determined elevations of the top of the Chattanooga shale is ample reason for believing that the morphology of the dome as shown on Map 51 is correct.

In the northeastern part of the area the homocline is modified by a structural terrace, the southern margin of which is at an elevation of 700 feet. Below this margin of the terrace the inclination of the top of the Chattanooga shale is 105 feet per mile. This rather steeply inclined surface forms the northeast limb of a pitching syncline which lies to the east of the dome. North of the margin of the terrace the surface of the structure rises gradually at a rate of about 25 feet per mile to the northern boundary of the area, where the elevation is a little more than 730 feet, the highest structural elevation in it.

In the north-central and northwestern parts of the area the amount of inclination of the homocline is fairly uniform.

The syncline south of the terrace previously mentioned, and northeast of the dome, pitches S. 45° E. A similar pitch for this syncline is shown on the map published by MacLachlan.

A quaquaversal syncline having a slight east-west elongation occurs northwest of the dome. The elevation of the bottom is between 630 and 635 feet. The only closed contour within the syncline represents an elevation of 640 feet.

The writers' representation of this structure differs from that of MacLachlan, whose map shows the syncline as opening to the south, with the 640-foot contour not closed, but curving southward around the dome and partly around a faulted anticline to the southwest. A saddle to the south of the syncline is indicated on his map by a constriction of the 640-foot contour line opposite the southeastern extension of the fault. The absence of outcrops which might give information relative to the elevation of the top of the Chattanooga shale precludes the possibility of determining from direct observation the exact nature of the structure. A factor which has a bearing on the position and the height of the

saddle south of the syncline is the orientation of the faulted anticline. The plane of the fault follows the crest of the anticline at Shinbone Cliff. It is possible, therefore, to obtain the direction of the trend of the anticline from the strike of the fault. MacLachlan [4] states that the strike of the fault is N. 22° W. If this were true, the anticline would pitch into a broad syncline west of the dome, and hence the saddle southeast of the anticline very probably would be low. The supposed lowness of the saddle, therefore, led MacLachlan to believe that the 640-foot contour was not closed. The writers plotted the fault and found its strike to be N. 55° W. The trend of the anticline, which coincides with this strike toward the northwest end of the dome, and the nearness of the dome very strongly indicate that the top of the saddle is higher than 640 feet. The height of the saddle leads the writers to close the 640-foot contour north of the saddle, thus accentuating the quaquaversal nature of the syncline to the north.

The fault at Shinbone Cliff is a normal one, with a displacement of 15½ feet measured on the base of the Brassfield. The dip of the fault plane, which is easily recognized by a thin band of gouge, is 89° to the northeast; the strike of the fault is N. 55° W.

A considerable drag of the Richmond, Brassfield, and Chattanooga strata occurs on the northeast or downthrown side of the fault. The 22-degree dip of the Brassfield strata near the fault decreases very rapidly toward the northeast and at a distance of about 150 feet from the fault is only 5 or 6 degrees.

On the southwest or upthrown side of the fault the beds are nearly horizontal for the first 5 feet beyond the fault; at a distance of 15 feet beyond the fault they dip 6° S. 75° W.

A few hundred yards southwest of the fault the dip of the strata changes to a northeast direction. This is well shown on the face of Shinbone Cliff and in Little Cub Creek. The Chattanooga shale does not have so great a dip as the underlying Brassfield and Richmond; it rests on the thin, even-bedded limestone of the lower part of the Richmond a few hundred yards southwest of the fault.

[4] *Op. cit.*, p. 306.

The reversal in dip noted above and the determination of certain elevations of the top of the Chattanooga shale indicate the presence of a nose at the western margin of the area to the southwest of the faulted anticline.

South of the saddle connecting the faulted anticline with the dome is a broad syncline, which flattens out to the south.

It is quite likely that the folding of the Chattanooga shale in the entire area took place during the interval between the cessation of deposition of this shale and the beginning of deposition of the New Providence sediments. This is indicated by the thinning of the lower part of the New Providence over the higher structural elevations of the top of the Chattanooga shale. The rather striking uniformity in thickness of the Chattanooga formation over the entire area suggests that there was very little erosion during the interval prior to the deposition of the New Providence.

POSSIBILITIES FOR OIL AND GAS IN AREA

Three wells have been drilled near the north end of the dome. Two produced gas; the third was abandoned at shallow depth. A short distance north of Forbush Creek one of the gas wells, before it became flooded with water, supplied the farmhouse of Mr. W. L. Scott with gas fuel for three or four years. The second well, which is about a quarter of a mile southwest of the first well, was drilled to a depth of 1,100 feet, but was permitted to become flooded as the result of improper casing.

So far as can be learned, four gas "sands" were encountered in these wells. According to the driller of the second gas well, the sands consist of porous zones within limestones. They probably occur in the Lexington or so-called Trenton group.

It is very likely that producing gas and oil wells may be drilled on the dome and possibly on the structural terrace.

Unfortunately, the number of wells drilled is insufficient to indicate the structure of the producing sands. However, intelligent drilling, based on the structure of the Chattanooga shale, will eventually make it possible to determine the nature of the subsurface structure.

FLINT, MICHIGAN

FIG. 1. Typical exposure of Chattanooga shale, about one hundred feet north of house of Mr. W. L. Scott, located one-quarter mile north of mouth of Forbush Creek

FIG. 2. Weathered shale of lower part of New Providence, shown on hillside about one-quarter mile east of mouth of Forbush Creek. Beaver Creek limestone is shown at top of shale; white irregular-shaped bands on surface of limestone represent chert

A NOTE ON THE STRATIGRAPHY OF THE BRUNSWICK FORMATION (NEWARK) IN PENNSYLVANIA

DEAN B. McLAUGHLIN

THE difficulty of recognizing individual beds in the Newark Series is traditional. Such statements as "The absence of easily recognizable strata . . . unfortunately renders it difficult to determine the structure of the region" [1] are of frequent occurrence in the literature. Most investigators of the Newark rocks have cautiously qualified their determinations of thicknesses of the formations by stating that the probable existence of undiscovered faults and the uncertainty of the displacement of known ones render all computations of thickness unreliable.

The continuity of the large formations along the strike has been recognized for many years, but the extent of individual beds appears to have received scant attention. Statements by Lyman [2] appear to indicate, though not perfectly clearly, that he believed that relatively thin beds could be recognized at localities some miles apart along the strike, although we shall see in the discussion which follows that he did not successfully identify definite horizons at different localities. Stose [3] states that in the Gettysburg area "individual beds and aggregates of beds maintain the same character for many miles along their strike. . . ." A very definite statement is made also by Darton and Kümmel [4] in regard to the Lockatong formation on the Hunterdon plateau of western New Jersey: "Hard dark-red flags are interbedded with the black argillite and some of the more prominent beds

[1] Russell, I. C., *U. S. Geol. Surv., Bull. 85* : 84. 1892.
[2] *Penna. Geol. Surv., Final Rep.*, 3, Part 2 : 2597 and 2605. 1895.
[3] *U. S. Geol. Surv.*, Folio 225 : 15. 1929.
[4] *Ibid.*, Folio 167 : 7. 1909.

can be easily traced for several miles along the strike. This has been done in so many cases at different horizons as to render it almost certain that this belt is not traversed by oblique faults of any magnitude."

Most investigators of the Newark rocks of Pennsylvania have mentioned the occurrence of dark shales interbedded with the red shales of the Brunswick formation, but the tendency has been to pass them by as of no consequence, and to regard them as thin lenticular bodies of trivial extent. This appears to be the view taken in the most recent publication [5] dealing with the same area as that studied by the writer. The statements by Stose and by Darton and Kümmel just quoted are the only indications that continuity of thin strata for some miles has been recognized anywhere in the New York-Virginia area of the Triassic. Hawkins [6] refers to "beds of passage" (interbedded red and black shales) at the transition from the Lockatong formation to the overlying Brunswick, but does not indicate that they are anything other than thin lenses of very limited extent.

The present paper reports results of a preliminary study of the black shales in the portion of the Brunswick formation below the Haycock diabase sheet in Bucks and Montgomery counties, Pennsylvania. Several good sections were studied, and their correlation was based almost entirely upon the tracing of the black shales along the strike from one section to another. In a few places, for distances not greater than six miles in any case, and less than four miles in all but one, the trend of definite topographic features has served to identify horizons in different sections.

In general the black shales [7] occurring in the Brunswick formation are lithologically indistinguishable from those of the Lockatong formation which underlies it. They are chiefly thick-bedded, hard, dark gray or greenish gray to black argillites. The weathered rock is usually olive-green to greenish yellow. Contacts

[5] *U. S. Geol. Surv., Bull. 828.* 1931.

[6] *N. Y. Acad. Sci., Annals,* 23 (1914) : 160.

[7] The term "black shale" will here be used to cover all gray, green, or black shales occurring in the Brunswick and Lockatong formations.

between the black shales and the inclosing red shale are not often sharp. Usually there is a foot or so of purplish or brownish shale marking the transition. In some localities the black shale contains beds of fine gray sandstone, and at others it is lighter in color and more fissile than the more common hard argillite. The black shales are more resistant to erosion than the inclosing red beds, and the course of a prominent black shale member is usually marked by a definite ridge.

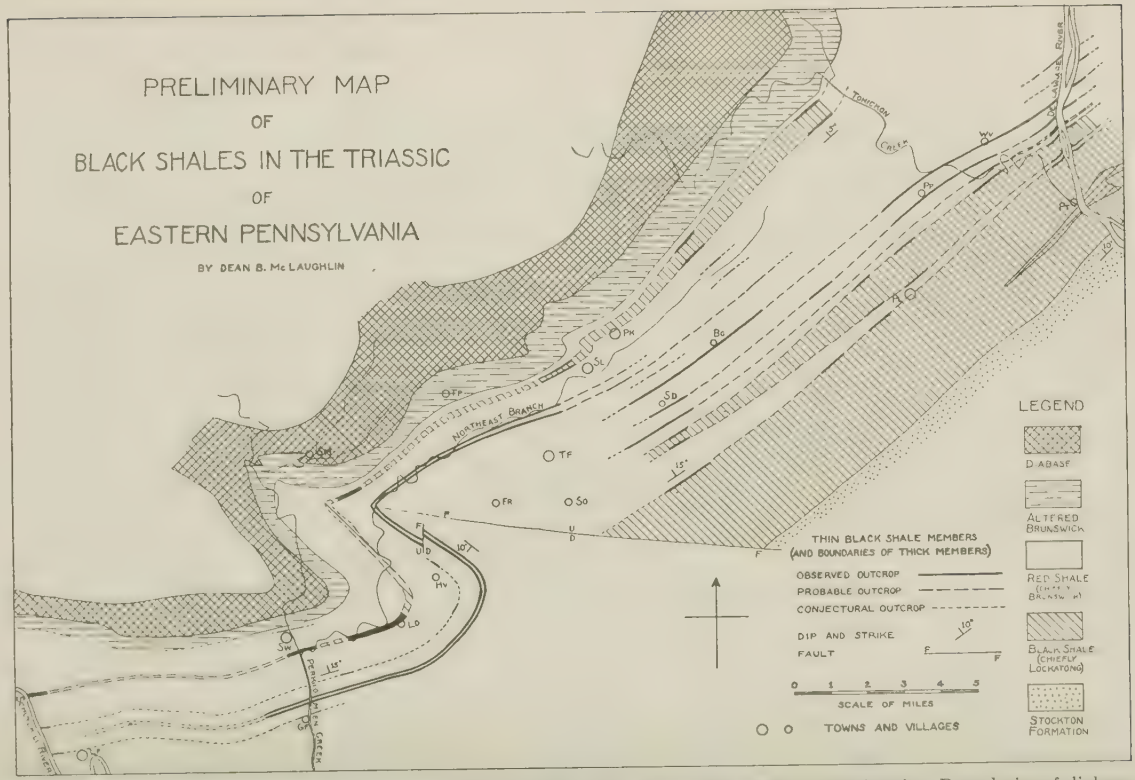
The observed outcrops of black shale are indicated by heavy full lines and diagonally shaded areas in the accompanying map (Map 52). Dashed lines show the probable course of outcrop in regions not yet examined. The lines of short dashes indicate uncertain correlations or conjectural continuations of observed outcrops. In the descriptions which follow, two-letter symbols after the names of villages serve to identify those villages on the map.

The writer's results can be most conveniently treated under three headings: (1) the Upper Lockatong and Lower Brunswick, which have been studied chiefly in Bucks County; (2) the Graters members; and (3) the Sanatoga member.

The Upper Lockatong and Lower Brunswick

In a previous paper the writer [8] has mentioned alternation of red and black shales in the Delaware River section. At the time that paper was written the interpretation was still in doubt; repetition by faulting had not been ruled out. In 1931 it was found that new road cuts along the west bank of the river had laid bare the rocks in almost continuous exposure for more than a mile, and most of the crucial contacts were easily found, conclusively proving the alternation to be due to interbedding. Exposures on the east and west banks were found to match very satisfactorily. The following section was measured on the west side of the Delaware River. The base of the section is one and one-quarter miles north of Point Pleasant (*Pt*); the top is about

[8] "The Thickness of the Newark Series in Pennsylvania and the Age of the Border Conglomerate," *Pap. Mich. Acad. Sci., Arts and Letters*, 16 (1931): 424.



MAP 52. Preliminary map showing distribution of black shales in the Triassic of eastern Pennsylvania. Boundaries of diabase from *U. S. Geol. Surv., Bull. 828*, and Lyman's map. Boundaries of altered Brunswick, with small modifications by the author, and Stockton-Lockatong boundary from the same bulletin. Mapping of black shales entirely by the author

Abbreviations: Bg, Blooming Glen; Fr, Franconia; Gf, Grater's Ford; Hv, Harleysville; Ld, Lederachsville; Lf, Linfield; Pk, Perkasie; Pl, Plumsteadville; Pp, Pipersville; Pt, Point Pleasant; Sd, Silverdale; Sl, Sellersville; Sm, Sumneytown; So, Souderton; Sw, Schwenksville; Tf, Telford; Tp, Tylersport; Wv, Wormansville

one-half mile up the bed of a tributary stream which flows from Wormansville (*Wv*) northeastward to the Delaware River.

SECTION ALONG WEST BANK OF DELAWARE RIVER NORTH OF POINT PLEASANT AND ALONG A TRIBUTARY STREAM

	Feet
Red shale	undetermined
Dark gray argillite, with some fissile shale (*D*)	72
Red shale, partly covered	400 ±
Dark gray argillite, partly covered (*C*)	100 ±
Red shale, partly covered	200 ±
Black argillite (few thin red beds) (*B*)	190
Red argillite, containing 30 feet of black	85
Black argillite, with few feet of red (*A*)	540
Alternate 20- to 30-foot strata of red and black argillite	150
Gray shale with some red, covered	undetermined

With the exception of the contacts of shale (*C*), every contact of red and black shale in this section is excellently exposed. On the basis of this section alone the top of shale (*B*) should probably be regarded as the top of the Lockatong formation, since it is immediately overlain by a large thickness of red shale typical of the Brunswick, containing smaller thicknesses of black shale. As nearly as can be determined from measurements on Lyman's map,[9] that author placed his Gwynedd-Lansdale contact at precisely the same horizon. However, the rapid westward thinning of (*B*) and the accompanying thickening of the red shale between (*A*) and (*B*) incline the writer to place the Lockatong-Brunswick contact at the top of shale (*A*). It must be borne in mind, however, that any precise definition of the boundary is, in the nature of the case, rather arbitrary.

The section above is supplemented by one measured partly along Tohickon Creek and partly on the hills about three miles west of the Delaware River. The shale (*D*) was traced continuously along the strike between the two sections, leaving no doubt as to the correlations indicated by assignment of letters to the dark shale members.

[9] *Penna. Geol. Surv., Final Rep.*, Atlas, sheets 10 and 11. 1895.

SECTION ON AND NEAR TOHICKON CREEK EAST OF PIPERSVILLE

Base of section at Smith's Corner; top at road intersection three quarters of a mile southwest of Wormansville

	Feet
Red shale, and upper beds of (*D*), unexposed	undetermined
Black argillite (*D*)	45
Red shale, partly covered	350
Dark gray argillite, with 30 feet of red (*C*)	130
Red shale	180
Red shale (?) exposures scarce	150
Red shale	20
Dark gray shale (part of *B*)	20
Covered region	130
Red shale (soil on hills, no exposures)	50
Gray shale (soil on hills, few exposures) (*A*)	> 400

The total thicknesses found for the strata between the top of (*A*) and the base of (*D*) in the two sections agree well, but there is a large discrepancy between the figures for the red shale between (*B*) and (*C*). Probably part of (*B*) in the Tohickon Creek section occurs in the region of scarce exposures, and the red shale above the observed part of (*B*) is an interbedded member. In both sections the strike is N. 50° E., dip 14° NW.

The member (*D*) was traced three miles southwest from Tohickon Creek. From that point the continuation of the strike, and also the topography, serve to connect it with a dark gray shale member of similar thickness which crosses the Doylestown-Quakertown highway one and one-half miles northeast of Blooming Glen (*Bg*). In the intervening stretch of four miles the positions of outcrop of (*C*) and (*A*) confirm this identification of (*D*).

In the vicinity of Silverdale (*Sd*) and Blooming Glen the composite section given below was obtained. Exposures are not numerous, and thicknesses are based chiefly upon dip and width of outcrop, the character of the rock being determined from fragments in the soil.

The pronounced thinning of shales (*A*) and (*B*), as compared with their thicknesses in the Delaware River section, and the accompanying thickening of the red shale separating them, are

COMPOSITE SECTION IN AREA ABOUT SILVERDALE AND BLOOMING GLEN

	Feet
Red shale	undetermined
Greenish gray shale (*F*), unexposed	15?
Red shale	250
Gray shale (*E*)	< 30
Red shale	400
Gray shale (*D*)	70
Red shale	520
Gray shale (*C*)	60
Red shale	350
Gray shale (*B*)	60
Red shale	500
Gray shale (*A*)	270
Red shale	undetermined

to be noted especially. A similar thinning of the main body of the Lockatong formation toward the west is well known.

The dark shales discussed above have not yet been traced to their end against the Chalfont fault. The member (*F*), however, has been followed around the end of the fault and is found to be part of the black shales which the writer calls the Graters.

The Graters Members

The Graters is a group of three strata of black shale, separated by comparable thicknesses of red shale, occurring about 2,200 feet above the base of the Brunswick formation in the Silverdale section. Owing to the westward thinning and probable disappearance of the upper argillite member (*A*) of the Lockatong formation and the thinning of the main body, the Graters is about 4,000 feet above the top of the Lockatong black shale in the Perkiomen Creek section. The writer has applied the name "Graters" because of the excellent exposures in Landis Brook just west of Grater's Ford (*Gf*) on Perkiomen Creek.

The shale designated (*F*) in the Silverdale section is the lowest of the three members of the Graters and occupies a well-defined ridge just south of the Northeast Branch of Perkiomen Creek. Northeastward from the Doylestown-Quakertown highway the Graters apparently thins decidedly and may disappear completely. Southwest of the highway the member (*F*) probably

thickens slowly for a few miles, then rapidly, for in a large quarry a mile north of Telford (*Tf*), thirty feet of black shale underlain by twenty feet of red shale are exposed. A fissile carbonaceous layer three feet thick occurs about fifteen feet above the base of the black shale. This same stratum has been identified in two more quarries within the next two and one-half miles southwestward along the ridge. The higher members are exposed at several places in the stream bed north of the ridge. Just west of the third quarry the ridge ends, and the intrenched meanders of the stream cross the strike of the hard rocks at several places in the next few miles. Three of these cuts across the Graters shales furnished the following composite section:

COMPOSITE SECTION OF GRATERS SHALES ON NORTHEAST BRANCH OF PERKIOMEN CREEK, ABOUT FOUR MILES WEST OF TELFORD

	Feet
Red shale	> 150
Greenish gray argillite, massive (*H*)	50
Red shale	30
Gray-green thick-bedded shale (*G*)	70
Red shale	30
Greenish gray shale (*F*)	60
Red shale	> 350

The exposures of the dark shales lead directly to the point where the Sumneytown road crosses the Northeast Branch, about three miles northwest of Harleysville (*Hv*), where a new deep road cut has exposed the rocks for a distance of over 200 yards. At the southeast end of the cut red shale is exposed, with strike N. 50° W., dip 15° SW., practically at right angles to the strike and dip of the shales in the stream east of there. Just northwest of this first exposure, for approximately 100 yards, the rock is badly shattered, and there are apparently at least three vertical faults causing alternation of red and gray shale along the strike. The rock in the northwest portion of the cut is red shale, and the strike changes quickly from N. 50° W. to N. 10° E., with gentle dip west, indicating a sharp fold. This locality is directly on the line of the Chalfont fault, which farther east has a displacement of over 10,000 feet. Probably the fault itself does

not extend as far west as this locality. The faults in the cut are small and local, for the gray-green shale occurs southeast of this faulted exposure with a strike directly toward it. The outcrop of dark shale through the sharp anticline may be regarded as practically continuous.

About two miles southeast of the faulted exposure, at a place about a mile northwest of Harleysville, the Graters shales are offset to the north somewhat more than one-quarter mile by a fault whose strike is approximately north. If we regard the movement as entirely vertical with downthrow on the east, the total displacement of the fault is a little less than 400 feet.

Southeastward the dark shales can be traced through a syncline which pitches northwestward. The line of outcrop crosses the Sumneytown road two miles southeast of Harleysville, and the lower member is exposed in contact with the overlying red shale, in a large quarry a mile southwest of the road.

Southwest of the quarry the trace of the outcrop changes from southwest to west-southwest. The Graters members cross the Skippack road just north of Lucon and pass through the grounds of the Eastern State Penitentiary to the Perkiomen Creek, which they cross about one-half mile north of Grater's Ford (*Gf*). Exposures occur in tributary streams on both sides of the Perkiomen, along the road on the east side, and in a railroad cut on the west. The best exposures, however, occur along Landis Brook, just west of Grater's Ford, where the following section was obtained:

SECTION ALONG LANDIS BROOK

Base of section near road bridge at western edge of village of Grater's Ford

	Feet
Red shale and fine sandstone	> 45
Greenish gray shale	6
Red shale	15
Gray shale and fine gray sandstone (*H*)	20
Red shale, partly covered	77
Gray shale, partly covered (*G*)	28
Fine red sandstone, partly covered	40 ±
Dark gray, thick-bedded argillite (*F*)	> 40
Fine red sandstone and red shale, partly covered	380
Dark gray shale	6
Red shale	165

So far as they are exposed, the rocks on the east and west banks of Perkiomen Creek furnished sections in good agreement with the table above.

The Graters members were not traced farther west, but evidence of their extent is furnished by the topography. Throughout the course described above, their outcrop is marked by a definite ridge. This ridge continues westward from the Landis Brook exposures, but comes to an end before reaching the Schuylkill River. In line with the course of the ridge a long covered stretch occurs in the section in the Philadelphia and Reading Railroad cuts on the east bank of the Schuylkill. It appears probable that the Graters shales underlie this covered interval.

The Sanatoga Member

The highest black shale member studied by the writer is here designated the "Sanatoga" because of the excellent exposures in a large quarry and in the railroad cut at Sanatoga Station on the Schuylkill River. It forms a part of what Lyman [10] called the Perkasie shales. Wherry [11] has pointed out that the Perkasie should not be regarded as a definite formation, since a large part of it is merely red shale which has been altered by the diabase intrusion. The Sanatoga member, however, although slightly altered in places, does not owe its dark color nor most of its hardness to baking.

About two miles southeast of Haycock Mountain the baked shale is underlain by about 90 feet of red shale. This in turn is underlain by greenish gray shale, the conformable contact being exposed. The thickness of green shale below the red is about 350 feet. The red stratum separating the baked shale from the naturally green shale persists southwestward along the strike. It is clearly evident on the Doylestown-Quakertown highway southeast of Rock Hill. What is believed to be the same stratum occurs in a ravine a mile west of Sellersville (*Sl*) and again on the Sumneytown road one and one-half miles southeast of Sumneytown (*Sm*). From there it is possible to trace the course of the

[10] *Penna. Geol. Surv., Final Rep.*, 3, Part 2 : 2609. 1895.
[11] *Proc. Acad. Nat. Sci. Phila.*, 64 (1912) : 376.

dark shale by means of the topography, taking account of the known course of the underlying Graters members. A well-marked ridge leads southward to Lederachsville (*Ld*), where large areas of the fields contain weathered black and green fragments. In this region the red shale above the black is almost a mile wide, for the diabase has migrated upward in the series.

Excellent exposures of the thick black shale member occur at the road bridge over the Northeast Branch one and one-half miles west of Lederachsville. An equal distance farther west this member crosses the main stream of the Perkiomen just south of Schwenksville (*Sw*) and is well exposed on the west bank, where the measured thickness is about 200 feet.

From the Perkiomen westward the course of this shale is indicated by a prominent ridge which reaches the Schuylkill River at Sanatoga Station, where the thickness is about 160 feet, including some interbedded red shale.

The relative positions of the Graters and Sanatoga members are indicated by the following section along Perkiomen Creek:

SECTION ALONG PERKIOMEN CREEK

Base at tributary stream on east bank, one-half mile north of Grater's Ford; top at the southern limits of Schwenksville

	Feet
Red shale	undetermined
Dark gray and green shale (Sanatoga)	200
Hard red argillite and red shale, partly covered	1200 ±
Covered, probably all red shale	180
Red shale, mostly covered (includes *H*)	630
Gray shale (*G*), middle Graters member	20

From the base to the top of the section the dip increases from 15 to 25 degrees. A corresponding uncertainty attaches to calculated thicknesses in the covered portions of the section.

It is of interest to compare the thicknesses along the Perkiomen with those along the Schuylkill River, given in the following section.

If the Graters members occur in the covered interval, then the thickness of red shale between the Graters and Sanatoga is only about 1,100 feet in the Schuylkill section as compared with

SECTION ALONG PHILADELPHIA AND READING RAILROAD

East bank of Schuylkill River, from Linfield at base, past Sanatoga Station, and along a tributary stream to Pottstown highway

	Feet
Red shale and sandstone, partly covered	600
Fine conglomerate and sandstone	5
Red shale and sandstone	340
Sanatoga black, green, and red shale	160
Red shale and fine red sandstone	280
Green shale and fine gray sandstone	5
Fine quartz conglomerate with few red shale pebbles	1.5
Red shale and fine red sandstone	105
Fine gray sandstone [12]	18
Fine gray and red sandstone, with diabase dike	500
Greenish gray sandstone	25
Red shale, partly covered	150
Covered, possibly containing Graters shales (*F*, *G*, *H*)	330
Red shale and sandstone, partly covered	250
Fine gray sandstone and gray shale (*E?*)	15
Red shale and sandstone	185

about 2,000 feet along the Perkiomen. If we attempt to correlate the Graters with the shale here designated (*E?*), we violate the topographic evidence. The conditions of deposition in the two sections were somewhat different, as shown by the greater amount of sandstone along the Schuylkill and the presence of thin beds of conglomerate. Only a few miles westward all the rocks of this section, except for the uppermost 600 feet or so, pass along the strike into conglomerate. A detailed study of this region of transition is contemplated.

Discussion

The courses of outcrop of the several dark shale members described above are shown in the accompanying map (Map 52). Owing to the difficulty of correctly representing the three members of the Graters, those shales are indicated by a double line. The Sanatoga can be readily identified as the broad belt of dark shales closely paralleling the altered shale just beneath the Haycock diabase sheet. The shales (*C*) and (*D*) pass very close to Pipers-

[12] At the base of this member there is an apparent angular unconformity, the significance of which is not clear.

ville (*Pp*) and Wormansville (*Wv*) respectively. A comparison and correlation of the four principal sections is given in Figure 24.

The present study leads to some revision of the identification of horizons which would result from a use of Lyman's map.[13]

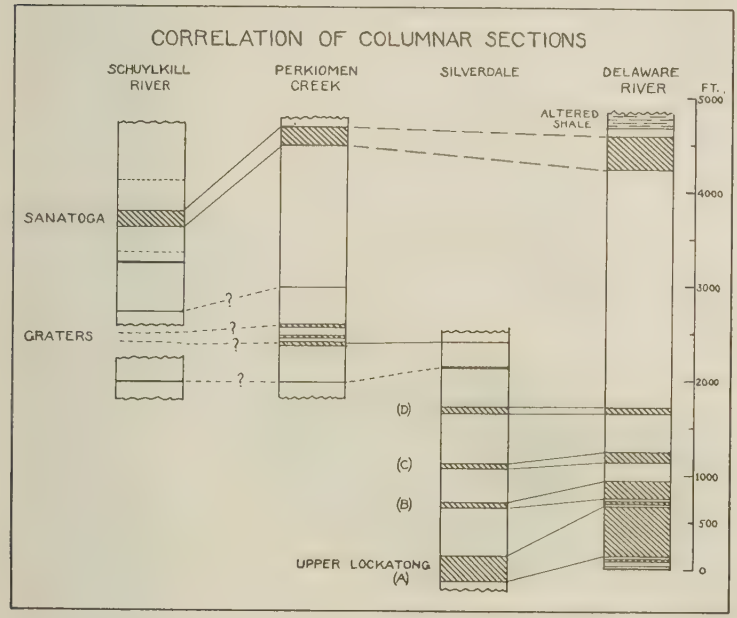


Fig. 24. Correlation of four sections of the Brunswick formation in eastern Pennsylvania. Explanation of figure: diagonal shading, black shale; clear, red shale; horizontal broken shading, altered shale; dotted lines, conglomerate. Correlation lines: full, certain correlation; long dash, probable correlation; short dash, conjectural correlation

Thus, according to that author, the member (*D*) would be 1,000 feet higher in the series near Silverdale than at the Delaware River. Again, the Graters near Sellersville would be regarded as about 1,500 feet lower stratigraphically than the same shale near Grater's Ford. Other similar discrepancies occur. It is thus evi-

[13] *Op. cit.*

dent that Lyman did not succeed in tracing thin members for long distances along the strike.

The writer's results also differ considerably from those of Wherry,[14] who has drawn the Lockatong-Brunswick contact cutting across some of the dark shale members at a considerable

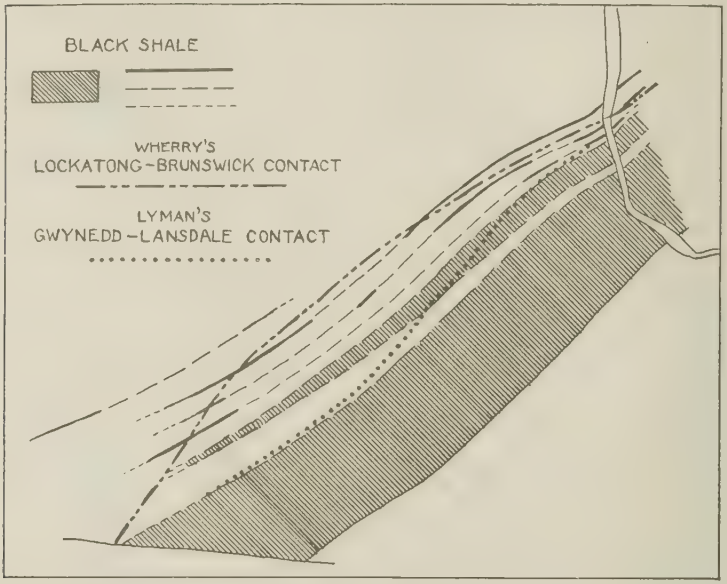


Fig. 25. Comparison of distribution of black shales with Lockatong-Brunswick boundary by Wherry and with Gwynedd-Lansdale boundary by Lyman

angle. He has also included in the Lockatong formation a large thickness of sediments which the writer would regard as lower Brunswick on the basis of the large ratio of red to black shale.

These discordances are shown in Figure 25, in which the distribution of black shales as observed by the writer is compared with the positions of the Gwynedd-Lansdale contact as mapped

[14] *U. S. Geol. Surv., Bull. 828.* 1931.

by Lyman and the Lockatong-Brunswick contact as mapped by Wherry.

It is evident that at any one time during the deposition of the lower Brunswick the conditions were far more uniform over considerable areas than has been previously supposed. The old concept of the merely local and lenticular character of the black shales in the Brunswick must be abandoned. The tracing of these dark shales furnishes a definite basis for identification of horizons at localities considerable distances apart.

It is also evident that small cross-faults may be detected by offsets of the dark shale belts, and if any important strike faults exist they will become evident from their effect in repeating such belts. The actual tracing of the black shales along the strike through regions of uniform dip and strike, as well as through the pitching folds in Montgomery County, should definitely dispose of the hypothesis that important repetition of beds by faulting has occurred — other than the repetition already recognized as due to the Hopewell and Chalfont-Flemington faults. It is inconceivable that important faults would continue so uniformly along the strike within the belts of outcrop of the red shales as to cause no offsets or cutting out of some of the black shale members. It can now be stated with considerable assurance that unrecognized strike faults are not likely to be responsible for more than a negligible percentage of the apparent thickness of the Newark Series in eastern Pennsylvania.

University of Michigan

CORRELATION OF THE UPPER HURONIAN OF THE MARQUETTE AND CRYSTAL FALLS DISTRICTS

JUSTIN ZINN

INTRODUCTION

AT THE present time the Upper Huronian of the Crystal Falls district is correlated with that of the Marquette district mainly on the basis of the continuity of the thick slate succession (the Michigamme slate) between these districts. In the geologic literature on these districts [1] no concise statements of the detailed succession of the sediments of the Upper Huronian have been given. The lower portion of the series in the Marquette district has been described and subdivided, but the upper part is grouped under the term "Michigamme slate"; in the Crystal Falls district the whole succession has been called the "Michigamme slate series." The data obtained by the field work of the Michigan Geological Survey in 1930 have made it possible to separate the Upper Huronian of the Marquette district into distinct lithologic units which may be correlated from place to place. These units are easily recognized, and appear to be in as well defined a succession as that of the Middle Huronian. It is of geologic importance to see whether the Upper Huronian has similar sequences in other districts. If definite lithologic successions do exist, then it should be possible to correlate the Upper Huronian in a detailed way from one iron-bearing district to

[1] Clements, J. M., and Smyth, H. L., *The Crystal Falls Iron-Bearing District of Michigan, U. S. Geol. Surv., Mon. 36* (1899) : 155–186; Van Hise, C. R., and Bayley, W. S., *The Marquette Iron-Bearing District of Michigan, U. S. Geol. Surv., Mon. 28* (1897) : 408–486; Van Hise, C. R., and Leith, C. K., *The Geology of the Lake Superior Region, U. S. Geol. Surv., Mon. 52* (1911) : 265–268, 298–300.

another, as has been done in the past in regard to the Middle Huronian. Such a correlation would be of twofold value. In the first place, it would give considerable information on the sedimentary changes from place to place in Upper Huronian time, and result in a more unified sedimentary history. In the second place, it would be of economic value, for the Upper Huronian iron formation could be more easily traced.

It is the belief of the author that the Upper Huronian sediments do have a definite succession which can be correlated between some of the pre-Cambrian areas, especially those which occur in Michigan. In this paper the attempt will be made to correlate the Upper Huronian sediments of the Marquette district with those of the Crystal Falls district. Such a correlation, to be of any consequence, necessitates the division of the Michigamme slate series into several parts or horizons, some of which may be given the distinction of formations. A subdivision of the Upper Huronian is especially necessary in the Crystal Falls area, since at the present time it is all included in the literature as the Michigamme.

The observations upon which the discussions of this paper are based were made during several summers of field work, of which the last two provided the most data. The summer of 1930 was spent with the Michigan Geological Survey in the Marquette district, in a detailed study of the area between Mt. Humboldt and Lake Michigamme. During the field season of 1931 the author covered in detail several small areas in the vicinity of the village of Crystal Falls. Two summers previous to 1930 were also devoted to the study of the Crystal Falls district and adjacent areas. It was not until 1931 that a definite succession in the thick Upper Huronian sediments of the Crystal Falls district seemed apparent to the author, and this recognition was facilitated by the knowledge of the Upper Huronian succession of the Marquette district, obtained during the previous summer.

It may be said that the Crystal Falls area is the northwestern extension of the Menominee district of Michigan and Wisconsin. In this paper, however, the whole Menominee district will not be

taken into consideration, but the discussion will be limited to the part which is in the vicinity of Crystal Falls village. This part is located in Iron County, Michigan, and continues westward toward the Iron River district and southward through the Alpha location to the Florence district in northern Wisconsin.

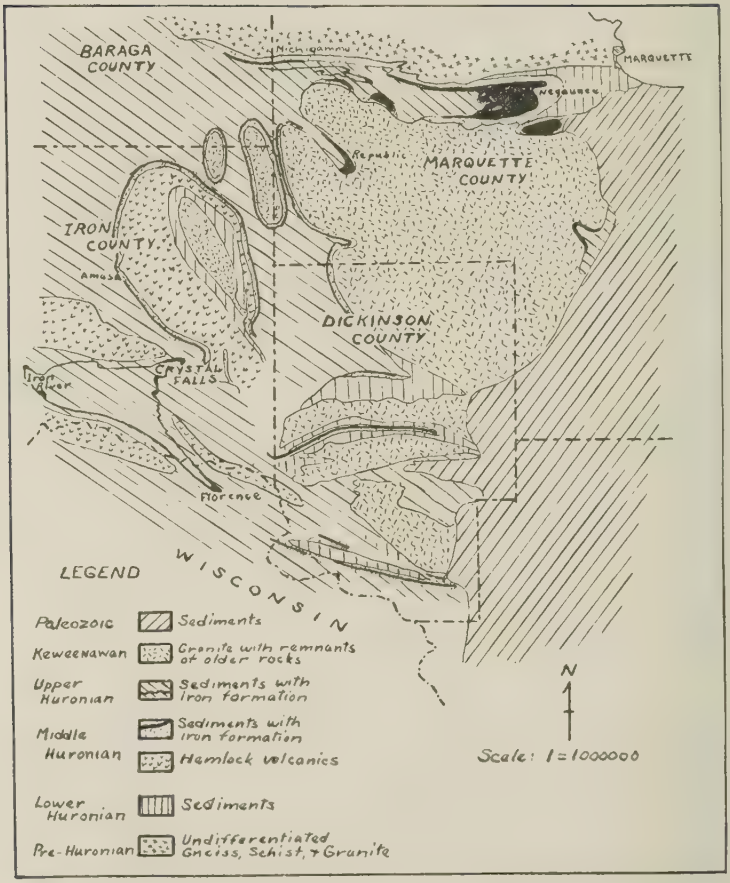
The western part of the Marquette district occurs about thirty-five miles northeast of Crystal Falls. It extends toward the east to Ishpeming and Negaunee in Marquette County. The area between these two districts is occupied by several anticlines or domes, which are commonly called "ovals." These ovals have granitic cores around the margins of which Huronian sediments occur. This intervening area is not well known geologically, since it has not been a large producer of iron ore and thus has not been extensively explored. It is not distinguished by a separate district name. The accompanying outline map (Map 53) shows the location of the areas which are concerned in this paper.

The attempted correlation of the Upper Huronian sediments in these two districts must be made in one step because of the meager amount of information obtainable on the area between them. The sedimentary succession in each area will be briefly described, after which certain points of similarity may be discussed. Elaborate descriptions of certain sections have been omitted, since they would make this paper unduly long.

THE BASE OF THE UPPER HURONIAN

The base of the Upper Huronian in each district is marked by an unconformity of some magnitude, and persons not familiar with the field observations might think it an easy matter to locate such an unconformity readily. With the exception of the Marquette district, however, the location of this base has been a question about which there has been much difference of opinion. In many places the unconformity is not marked by a well-defined conglomerate, and beveling of beds is not easily proved where outcrops are not numerous. In other places it has not been clear where the base should occur because of incorrect correlations of the iron formations.

The base of the Upper Huronian has been well established in



Map 53. Outline map showing the location of the Marquette and Crystal Falls districts and the general areal geology

the Marquette district. The unconformity between the Middle and Upper Huronian of this district is distinctly marked in most places by the Goodrich conglomerate and quartzite. It is also marked by the beveling of the Negaunee iron formation. There

is no sedimentary horizon of Middle Huronian age above the Negaunee in the Marquette district; thus the base of the Upper Huronian series may be found just above this iron formation in places where it is not missing.

The unconformity between the Middle and Upper Huronian is not easily distinguished in the Crystal Falls district. The competent quartzitic basal sediment of the Upper Huronian does not occur in this area, and the Negaunee iron formation is found only in the eastern part of the area. In the past, the base of the Upper Huronian has been placed at three different horizons, namely, at the top of the Hemlock volcanics, above the principal iron formation of the Crystal Falls district, and, later, upon the recognition of two different iron formations, above the lower and below the upper of the iron horizons. The last interpretation places one iron formation in the Middle Huronian and the other, which is the principal producer of the district, in the Upper Huronian. In *Monograph 52*[2] of the United States Geological Survey the unconformity between the Middle and Upper Huronian of the Crystal Falls district is put at the top of the Hemlock volcanic formation in all places on the southwest side of the Crystal Falls oval. Allen and Barrett[3] put the unconformity above the Vulcan iron formation and in this way classed all the iron formations of the district as Middle Huronian. Subsequent detailed magnetic field work has shown that there are really two different iron formations in this area. The lower iron formation, which occurs in a succession of sediments which are conformable above the Hemlock volcanics, has been correlated with the Negaunee formation of the Marquette district. The correlation is based upon lithologic similarity and the continuity of the magnetic line associated with the Negaunee formation from the west end of this district. A satisfactory discussion of it is given by Allen and Barrett.[4] The higher or later iron formation occurs in a series of sediments which are unconformable above the Hemlock volcanics. It extends from Crystal Falls westward and southward

[2] Van Hise and Leith, *op. cit.*, p. 299.

[3] Allen, R. C., and Barrett, L. P., "Contributions to Pre-Cambrian Geology," *Mich. Geol. and Biol. Surv.*, Publ. 18 (1915) : 26.

[4] *Op. cit.*, p. 25.

to Iron River and Florence. This higher formation is now considered to be of Upper Huronian age by most of the geologists who are familiar with the Crystal Falls district, and has been distinguished as such on the geologic map of Iron County which was published by the Department of Conservation of the State of Michigan in 1929. The discussion in this paper is on a basis conforming to the last interpretation. The base of the Upper Huronian in the Crystal Falls district occurs, therefore, somewhere between these two iron formations. It overlies the beveled Middle Huronian series, resting on the Hemlock volcanics in most places south and west of Crystal Falls. Around the large oval to the northeast of this village, however, it rests on remnants of the Negaunee iron formation or on a Middle Huronian slate conformably overlying the Negaunee, both of which occur above the Hemlock volcanic greenstone in this part of the district. At no place in this area, however, are there outcrops that show the unconformity between the Middle and Upper Huronian, and the data given are based on observations in diamond drilling and in mine workings. The uncertainty about the base of the Upper Huronian in the Crystal Falls district is thus more apparent.

THE MARQUETTE DISTRICT

The Upper Huronian sediments of the Marquette district are divided into the following formations:

Upper Michigamme	graywacke, quartzite, slate
Bijiki	iron-bearing
Lower Michigamme slate	
Clarksburg	volcanic sediments
Greenwood	iron-bearing
Goodrich	conglomerate, quartzite, etc.

Each of these formations will be described in sufficient detail for identification and for a later comparison with the succession in the Crystal Falls district. For a fuller description the reader may be referred to the report on the field work of the Michigan Geological Survey in 1930.[5]

[5] Zinn, J., "Geology of the Portion of the Marquette Range between Humboldt and Lake Michigamme," *Mich. Geol. Surv.*, 1931. Available in mimeographed copies.

The Goodrich Formation

The Goodrich formation lies unconformably above the Middle Huronian sediments, beveling off in many places the Negaunee iron formation and perhaps even the Siamo slate. It consists of a basal conglomerate overlain by quartzite and quartz slate. The conglomerate ranges in thickness from a few feet to several hundred feet and is composed of pebbles of iron formation, quartzite, and granite, in a matrix of finer material of the same character. The Goodrich conglomerate shows the greatest development in the Marquette syncline from Mt. Humboldt eastward and is especially thick in places on the south side of the syncline. In the west end of the district the conglomerate is thin and, in some places, missing. The quartzite overlies the conglomerate and grades downward into it. Most of the quartzite is composed of rather pure quartz sand that forms thick, massive, light-colored beds. It, also, appears to be thicker in the southern and eastern parts of the district. It grades upward into quartz slate and, in places, into true slate. To show the variation of the Goodrich formation from place to place the section of this formation at Michigamme may be compared to that at Mt. Humboldt. At the latter locality there are about two hundred feet of basal conglomerate overlain by several hundred feet of quartzite, above which some slate occurs. At Michigamme the whole formation is only about two hundred feet thick, and is made up almost entirely of the quartzite. For correlation purposes important facts to keep in mind regarding the Goodrich formation are that it is variable in lithology within short distances, and that it seems to become uniformly thinner toward the west.

The Greenwood Formation

At the top of the Goodrich formation occurs the Greenwood ferriferous horizon. This sediment is not a pure iron formation, but was deposited as an interlayered accumulation of clastic material and chemically deposited chert and siderite. The parts exposed in outcrops now consist of grunerite schist, with interlayered chloritic material or quartz sand. The unmetamorphosed

portions are probably a sideritic slate. The thickness of the Greenwood formation varies somewhat, being perhaps fifty feet at a minimum. Where metamorphosed, it is magnetic and creates a magnetic line that marks the top of the Goodrich formation. Where the Greenwood is overlain by the Clarksburg volcanics, the interlayered clastic zones seem to be mostly chloritic material, but where the Clarksburg is not present, as at Michigamme, the interlayered material is mostly clastic quartz. This iron horizon has not yet proved to be of economic importance.

The Clarksburg Formation

The Clarksburg volcanic formation is limited to the south side of the Marquette syncline and extends from Ishpeming westward to a short distance east of Lake Michigamme. It consists mainly of agglomeratic and ash beds, having in most places interlayered normal sedimentary horizons. Very few lavas are to be found. The volcanic rock is rather basic, probably being the equivalent of gabbro in composition. The observation that the volcanics occur on only one side of the Marquette syncline indicates the local extent of the formation and suggests that this horizon may not exist at all in other districts.

The Lower Michigamme Slate

The Michigamme slate series of the Marquette trough includes within it the Bijiki iron formation which divides it into two parts. The part below the iron formation will be considered first.

The lower slate lies conformably upon the Clarksburg volcanic sediments, and, in the places in which the Clarksburg is missing, conformably upon the Greenwood iron horizon. This condition suggests that the Clarksburg occupies the lower part of the time interval of the lower slate, and, further, that it grades laterally into this slate. The basal part of the slate is chloritic, but it grades upward through a gray variety into a black carbonaceous or graphitic slate which lies just below the Bijiki iron formation. The slate varies in thickness from three hundred to five hundred or more feet.

The Bijiki Iron Formation

The Bijiki iron formation occurs near the base of the Michigamme slate series, and detailed field work has demonstrated it to be a continuous, well-defined horizon. It consists of ferruginous cherts, and, where metamorphosed, of grunerite schists. The original material was undoubtedly cherty siderite. The formation is from fifty to seventy-five feet thick in the Marquette district. The Bijiki, in general, contains very little clastic sediment, being nearly pure chert, interlayered with iron-bearing minerals. It does, however, contain some graphitic material, which may be seen in the gruneritic phases. It differs from the Greenwood formation in being associated with graphitic slates and in having very little clastic admixture. Several mines have been located in the Bijiki formation in the past, and the Imperial mine at Michigamme is still active. This formation is thus a productive horizon.

The Upper Michigamme Formation

The part of the Michigamme series above the Bijiki iron formation is much thicker than that below, and is the highest horizon of the Upper Huronian that has been recognized. Immediately above the Bijiki this formation is a highly graphitic slate, but this slate passes upward very abruptly into a dark graywacke and quartzite. Some horizons of the coarser sediment are a dark felspathic quartzite, which in some sections approaches conglomerate in texture, whereas in other sections the sediment is a black, finer-grained graywacke. These gradations are lateral as well as vertical. In some places at or near the base of the coarser clastics lenses of conglomerate occur. They contain pebbles of chert, quartz, and graphitic slate in a matrix of quartz sand. The conglomeratic lenses and the quick transition to coarse clastic sediment above the Bijiki horizon suggest a temporary break in the sedimentation of the Upper Huronian series. Not much true slate is found in the Upper Michigamme formation in the Marquette district. The highest horizon of the formation seen was still coarsely clastic. The thickness of the graywacke series may be two thousand feet or more.

No specific figures can be given for the total thickness of the Upper Huronian of the Marquette district. Relative thicknesses may be shown, however, indicating what seems to be characteristic of the succession. The sediments up to the Greenwood formation range from about three hundred feet as a minimum to perhaps ten times this thickness as a maximum. The sediments above the Greenwood, with the exception of the Clarksburg, which is local, seem to be of a much more even thickness. The study of the sediments gives one the impression that the lower part of the Upper Huronian largely fills up irregularities which were present on the Middle-Upper Huronian erosion surface.

THE CRYSTAL FALLS DISTRICT

For several reasons the Upper Huronian succession cannot be so easily studied in the Crystal Falls district as in the Marquette district. Magnetic lines are not so numerous or so strong, so that magnetic surveys do not give so much information. Outcrops are scarce in most places where the interpretation is questionable, and the different horizons are not so easily identified lithologically. For the present discussion the Upper Huronian sediments are included under the following subdivisions:

Upper Michigamme formation.	graywacke and slate
Crystal Falls iron formation	
Footwall slates.....	graphitic and pyritic
Basal sediments.....	conglomerate, graywacke, and slate

In the past, these divisions have generally been grouped under the term "Michigamme slate," and the iron formation has generally been called the "Vulcan member." This formation in the Menominee range proper is now thought to be of Middle Huronian age and thus is to be correlated with the Negaunee formation, whereas there is little doubt that the iron formation of the Crystal Falls, Iron River, and Florence districts is Upper Huronian. For this reason the iron formation at Crystal Falls will be referred to in this paper as the "Crystal Falls formation" and not as the "Vulcan." It should be kept in mind that it is entirely distinct and stratigraphically higher than that which has been traced around the large granite oval to the northeast of Crystal Falls.

The Basal Sediments

The location of the actual base of the Upper Huronian has not been determined at many points in the Crystal Falls district. For this reason the true stratigraphic positions of some of the outcropping sediments, near where the base should be, cannot be definitely given. The basal conglomerate has been exposed in mine workings at Amasa,[6] and test pits show the conglomerate at the Redrock mine location north of this village. At the latter place it is composed of fragments of iron formation and of greenstone. Near the Alpha location south of Crystal Falls numerous outcrops show the type of sediments below the graphitic slate footwall of the Crystal Falls iron formation. Immediately below the graphitic slate occurs a gray, fine-grained, and well-banded slate. A short distance above the Middle Huronian Hemlock greenstone there is a fine-grained, chloritic graywacke, which is thought to grade upward into the gray slate. Green chloritic and gray slates have been encountered just east of Crystal Falls below the graphitic slates, but the lowest sediments at this place have not been seen or explored. The thickness of the basal sediments varies decidedly within relatively short distances. Just east of Crystal Falls they seem to be many hundreds of feet thick, but west of this village at the Fortune Lake mine location it is reported that the Crystal Falls iron formation occurs immediately above the Hemlock greenstone, thus allowing only a very small thickness for both the graphitic footwall slates and the basal sediments. The abundance of chloritic graywacke and slate incorporated in the basal sediments which have been described suggests a considerable erosion of the underlying Hemlock greenstone. This deduction is supported by the fact that only remnants of the Middle Huronian sediments, which occur above this greenstone, still remain in the Crystal Falls district.

The Footwall Slates

The footwall graphitic slates are found above the gray slates and immediately below the Crystal Falls iron formation. They

[6] Allen and Barrett, *op. cit.*, p. 26.

are fissile black slates which contain much carbonaceous or graphitic material and generally also much pyrite. Some of them burn when ignited. This sediment ranges in thickness from ten to fifty or more feet. It grades downward into the underlying gray slate.

The Crystal Falls Iron Formation

The Crystal Falls iron formation consists of rather thick horizons of cherty siderite, interlayered with thinner horizons of ferruginous or graphitic slate. The cherty siderite may be relatively pure or may contain some pyrite and graphite. There are two or perhaps more principal horizons of the cherty siderite. The whole iron formation is of considerable thickness if the interlayered slates be included. At Crystal Falls it outcrops over a width of about a quarter of a mile and is steeply dipping, but in the exposure in question there may be some duplication by folding. To the west and south it becomes thinner in most places. The iron formation, which lies conformably above, grades abruptly into the footwall slates. It passes in the same manner into the hanging-wall sediments above it. It has been traced almost continuously to the Iron River district to the west and to the Florence district to the south. This continuity is sufficient to show that the Crystal Falls iron formation is a definite horizon and not a series of discontinuous lenses.

The Upper Michigamme Formation

In most places the sediment immediately above the Crystal Falls iron formation is a graphitic slate very similar to the footwall slates. In some mine workings and drill holes it is difficult to tell which was the top and which the base of the iron formation, because the slates are so similar on each side and because the exploration is not carried far enough outside the iron formation to permit a study of the transitions. In the Crystal Falls district, however, the hanging-wall slate seems to be thin, giving place upward to a relatively coarse grained quartzose graywacke. This graywacke, which is dark gray to black with incorporated carbonaceous material, varies in composition from a normal sediment of the graywacke type to one which approaches a quartzite. It

may be distinguished from the graywacke which forms part of the basal sediments by the large amount of quartz sand and lack of chloritic material. Higher horizons of this formation, so far as can be determined from outcrops, are either graywacke or coarse gray to black slate. The lower horizons of the graywacke are somewhat magnetic in places and the tracing of it by the dip-needle has helped in locating the iron formation below it. The base of the graywacke has horizons of chert breccia within it in at least one locality. There are some reasons for believing this breccia to be sedimentary rather than deformational. The horizons parallel the base of the formation and grade laterally into the quartzitic graywacke. No chert horizons were found in the graywacke series which could have been broken up by folding to produce the breccia. If this breccia is sedimentary, it indicates a slight erosional interval at the base of the Upper Michigamme sediments.

The graywacke slate series is the highest Upper Huronian formation to be recognized in the Crystal Falls district. Its thickness is not known, but may be several thousand feet. This formation, which has been called the "Paint slates" by Allen and Barrett,[7] is said by them to extend widely to the west and north of the Crystal Falls district.

CORRELATION

With brief statements of the succession of sediments in the Crystal Falls and Marquette districts and short descriptions of these sediments given, it is now possible to point out evidences upon which correlations can be made. Definite horizons of the Upper Huronian have not yet been continuously traced from one district to the other; consequently, the only means of correlation which can be used at the present time are by lithologic resemblance and similar stratigraphic successions. The correlation may best be started with the top of each succession and the consideration of the lower formations may be made in order.

The highest recognized formation of the Upper Huronian in each district under consideration is the thick, quartzitic gray-

[7] *Op. cit.*, p. 131.

wacke slate. In the Marquette district this sediment is quartzitic enough in places to be called a quartzite; at one time it was mistaken for the Goodrich quartzite. It is felspathic, however, and contains enough carbonaceous material to give it a predominant dark color. In the Crystal Falls district the graywacke slate is not quite so quartzitic, and the coarsest horizons are more truly graywacke than quartzite. This formation of the latter district seems to contain more slate, at least in the higher horizons, than is found in the Marquette district. It also contains carbonaceous material in the base, and this gives it a dark gray to black color. In each district the base of the graywacke formation contains conglomerate lenses which, as suggested above, may indicate a temporary break in the Upper Huronian sequence. In both places this sediment directly overlies the principal Upper Huronian iron formation. The set-ups in the districts are so nearly alike that there should be no serious doubt in concluding that the Upper Michigamme formation of the Marquette district is the counterpart of the graywacke slate formation of the Crystal Falls district. The correlation seems more likely when one considers that there are no other formations of either district which are lithologically similar to the carbonaceous, quartzitic graywacke.

In the Crystal Falls district the Upper Michigamme formation contains more slate than in the Marquette district, but it is much thicker, occupying broader synclines, and it may be that most of the slate phases are in the higher horizons which are not present in the Marquette syncline. On the other hand, the formation may become coarser and more quartzitic toward the latter area. So far as known at present, there are no iron-bearing horizons in the Upper Michigamme formation, and the only marker horizon of it which is easily recognized in each district is its base. This sediment makes up more than half of the volume of the Upper Huronian sequence.

The Bijiki iron formation directly underlies the Upper Michigamme in the Marquette district and at Crystal Falls the Crystal Falls iron formation is present beneath it. This observation alone suggests that these two iron formations represent the same

Upper Huronian iron-bearing horizon. Lithologically, the Bijiki and the Crystal Falls are almost identical. They have about the same chemical composition and both of them are associated with graphitic slates. Much of the Bijiki now exists as gruneritc schist, whereas the Crystal Falls formation has no gruneritic phases; but this character is a secondary change due to metamorphism and does not depend upon the original composition. The Crystal Falls is several times as thick as the Bijiki, and it includes interlayered slate horizons whereas the Bijiki formation does not, but aside from these differences, there seems to be nothing of importance which would suggest that these iron-bearing horizons are not of the same age.

There are two horizons of ferruginous deposition in the Upper Huronian of the Marquette district, the Bijiki and the Greenwood formations, but, so far as known, the Crystal Falls district has only one in this division of the Huronian. The Greenwood iron formation is not of economic importance, but the possibility that it is of the same age as that at Crystal Falls should be considered. The Greenwood may be equivalent to the Crystal Falls, or it may be of the same age as the lowest part of this formation, or it may be at a lower horizon entirely, and not existent in the Crystal Falls district. There is little reason for believing that the Greenwood rather than the Bijiki is equivalent to the Crystal Falls iron formation, since the latter is so much more like that at Crystal Falls. It is possible, however, that the Greenwood is equivalent to the lower part of the Crystal Falls formation. If the Clarksburg volcanic sediments, which are known to be local, are disregarded, the only sediment occurring between the Bijiki and the Greenwood is the lower Michigamme slate, which on the average is not very thick. If the Greenwood formation is of the same age as the lower part of the Crystal Falls, then the Bijiki could be correlated with the upper part of the Crystal Falls, and the intervening slate would be represented in the Crystal Falls district by the interlayered slate horizons in the iron formation of this place. An observation which would support this hypothesis is that the combined thickness of the Greenwood and the Bijiki with the intervening slates does not greatly exceed

the thickness of the Crystal Falls formation. The lower part of this sediment is associated with carbonaceous material as well as the top of it, however; whereas the Greenwood is stratigraphically lower than the graphitic horizon of the Upper Huronian in the Marquette district. If the carbonaceous deposition of each district was contemporaneous, then it would necessarily follow that the Greenwood horizon is lower stratigraphically than the Crystal Falls iron formation. At the present time it is not possible to correlate the Greenwood definitely with any horizon of the Crystal Falls district, and the question will be left open until further data on the extent of the Greenwood are obtained.

The higher formations of the Upper Huronian of these districts have now been tentatively correlated and attention may be turned to the basal members. There is little similarity between the basal sediments of the Crystal Falls and Marquette districts. Except for the fact that the higher formations have been correlated there would not be much reason for saying that these lower sediments are of the same age.

The basal conglomerate in each district is composed in part of fragments of the rock which underlies it at any one place. For instance, the Goodrich conglomerate of the Marquette district has a high percentage of iron-formation breccia at those places where it overlies the Negaunee iron formation, and a smaller amount of such material where this iron formation was removed by erosion before the deposition of the sediment began. In the Crystal Falls district the basal conglomerate and graywacke are composed mainly of greenstone débris where they overlie the Hemlock volcanic formation, and of iron-formation fragments where remnants of the Middle Huronian iron formation remain beneath. These observations show that much of the material forming the basal sediments was incorporated without being moved far from its source. The local character of these sediments was probably the result of deposition over a moderate topographic relief on the Middle-Upper Huronian erosion surface. An uneven surface of some magnitude is indicated by the amount of beveling which the Middle Huronian sediments experienced. At Mt. Humboldt the Negaunee iron formation is estimated to be about

a thousand feet thick, although less than a mile west of this place it is entirely missing. At the Armenia mine location in the Crystal Falls district the Negaunee formation, with at least three hundred feet of Middle Huronian hanging-wall slates, occurs, but three miles to the west these sediments are missing, together with all the underlying slate and some of the Hemlock volcanics. There seems to be sufficient reason, therefore, for expecting the basal sediments of the Upper Huronian to have local facies. The difference in lithology, then, does not bar the correlation of these sediments from one district to the other. The Goodrich formation of the Marquette district is essentially quartzose because the underlying terrain, with the exception of the Negaunee iron formation, is quartzose and granitic. The basal sediments of the Upper Huronian of the Crystal Falls district are mainly chloritic slates and graywackes because they are underlain throughout this district by the thick Hemlock volcanic greenstone, except where remnants of some of the higher formations of the Middle Huronian remain beneath the Middle-Upper Huronian unconformity.

Since certain horizons of the Upper Huronian of the Crystal Falls district may be correlated with similar ones in the Marquette district, and since the underlying Middle Huronian sediments of these districts have been correlated, it appears probable that the basal sediments of the Upper Huronian, which have been discussed above, are of the same age. The foregoing discussion shows, however, the difficulty which would have been encountered had the attempt been made to start the correlation with the base. The accompanying chart shows the correlation which has been discussed.

FUTURE CORRELATION

It should not be difficult to correlate the Upper Huronian sediments which might in the future be investigated in the area between the Marquette and Crystal Falls districts. Two horizons, the quartzose graywacke slate and the iron formation, should occur with the same characteristics which they have in these districts, and for this reason they should be readily identified. The basal sediments should be found with local facies, as they

	Previous correlation *		Correlation as discussed	
	Marquette district	Crystal Falls district	Marquette district	Crystal Falls district
Upper Huronian	Greenstone intrusives and extrusives		Upper Michigamme formation	Upper Michigamme formation (Paint and Hanbury slates)
	Michigamme slate, partly replaced by Clarksburg volcanics	Michigamme slate	Bijiki iron formation	Crystal Falls iron formation
			Lower Michigamme formation	Footwall graphitic slates
			Clarksburg volcanic formation	
	Bijiki schist (iron-bearing)		Greenwood formation (iron-bearing)	
	Goodrich quartzite		Goodrich formation	Basal conglomerate graywacke and slate
	Unconformity			
Middle Huronian		Paint slates?		
		Greenstone intrusives and extrusives		
		Hanbury slate		Slate
	Negaunee iron formation	Vulcan iron formation	Negaunee iron formation	Negaunee iron formation "Vulcan"
	Siamo slate	Ajibik quartzite	Siamo slate	Slate
	Ajibik quartzite	Mansfield slate	Ajibik quartzite	Hemlock volcanics
		Hemlock volcanics		

Chart showing previous correlation between the Marquette and Crystal Falls districts by Allen and Barrett, and the correlation suggested by later investigation

* Allen and Barrett, *op. cit.*, p. 30.

have been in the two districts described. In the areas where the Hemlock formation does not exist, the basal formation of the Upper Huronian may more closely resemble the Goodrich formation of the Marquette district.

It is probable that the correlation of the Upper Huronian sediments may be extended to other iron-bearing districts of Michigan. The discussion of these has shown that the Upper Huronian does have some easily identified horizons which are extensive. The Upper Michigamme formation has certain characteristics which should facilitate its identification over a wide area where it may exist. It is noteworthy that this formation is more or less quartzose, and that it has much coarsely clastic material in it. This may imply a renewed erosion of the land areas which were supplying the material for this formation. The land areas may have been reëlevated, perhaps by the forces which later folded the whole Huronian sequence at the end of Huronian time. If these deductions are correct, then one should expect the Upper Michigamme formation to be a sandy clastic sediment in most places. The lower portion, at least, of this formation contains carbonaceous material, and for this reason the sediment is generally very dark colored. This characteristic distinguishes it from all stratigraphically lower quartzite formations of the Huronian.

The Upper Huronian iron formation in both the Crystal Falls and the Marquette districts is characterized by its close association with graphitic slates. There is in this instance the association of two unusual types of deposition. It may be conceded that the sedimentary deposition of cherty siderite is unusual and must be explained by special processes. Likewise, sedimentary deposition of carbonaceous material seems to be unusual in the pre-Cambrian, since up to the present time there has been found only one horizon in the Huronian of the Lake Superior region containing this material. It seems improbable that more than one sedimentary horizon will be found in the Huronian which has this association of iron formation and carbonaceous material. Since this peculiar sedimentation has been demonstrated to be Upper Huronian in these two districts, it may well be that any

iron formation which in the future should be found associated with carbonaceous or graphitic slates is of Upper Huronian age. On this basis it should be possible to correlate the Upper Huronian as accurately as the underlying Huronian groups have been correlated in the past.

CONCLUSIONS

Recent field work in the Marquette and Crystal Falls iron-bearing districts of Michigan has produced data which show a more or less definite succession of Upper Huronian sediments in each area. A comparison of their sedimentary sequence leads to the conviction that at least some horizons can be correlated from one district to the other. There seems to be sufficient ground for believing that the Upper Huronian iron formation of the Crystal Falls district is of the same age as the Bijiki formation of the Marquette district. The overlying quartzose graywacke slate which is found in each area is also thought to belong to one formation. There is some evidence for believing that there may be a sedimentary break at the base of this graywacke slate formation. Though the sediments underlying the iron formation in each district are quite dissimilar, reasons have been given for believing that they are contemporaneous. The conditions of sedimentation during the lowest part of the Upper Huronian deposition were such that local facies developed, with the result that the type of sediment found at any one place depends somewhat upon the character of the underlying rocks.

It is probable that field work in other iron districts of the Lake Superior region will give sufficient data on the Upper Huronian rocks encountered to show successions which may, in part at least, be correlated with the better-known sequences of the Marquette and Crystal Falls districts.

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LENGLET DU FRESNOY: A BIBLIOGRAPHY

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THE eighteenth-century French scholar, the Abbé Nicolas Lenglet du Fresnoy, has received but scant attention in the world of modern erudition. There has been no account of his life and works since 1761, and with the exception of very brief mention in diverse publications his name is practically unknown. In view of his apparent position in eighteenth-century historiography, the lack of accessible and organized information concerning him and the new facts relating to his life found in the archives of the Bastille, a short biography of his career seems to be justified.[1]

[1] The only existing biography of the life of Lenglet du Fresnoy is the book of J. B. Michault (of Dijon), *Mémoires pour servir à l'histoire de la vie et des ouvrages de Monsieur l'abbé Lenglet du Fresnoy* (Paris and London, 1761). This work has been used as a source for the accounts of Lenglet's life given in the two following works: *La Nouvelle Biographie générale*, published under the direction of Dr. Hoefer, by Firmin Didot Frères of Paris in 1842, and Michaud's *Biographie universelle*, also published in Paris (no date). J. M. Quérard in *La France littéraire, dictionnaire bibliographique, sélon La France littéraire de 1769* (republished by Firmin Didot Frères of Paris, 1833) gives a very complete bibliography of Lenglet du Fresnoy's own writing, and Joseph Delort in his *Histoire de la détention des philosophes*, (Paris, 1829) 2 : 41–112, has given a documented account of Lenglet's imprisonments. These works represent the only published material on Lenglet's life. Unfortunately, the limits of this paper allow the use of only as much of this material as is necessary for the continuity of the text.

Ernst Bernheim, in his *Lehrbuch der historischen Methode* (Leipzig, 1908), devotes a small paragraph of insufficient length and comprehension to Lenglet's place in eighteenth-century historiography; a longer and more accurate account is presented by Allen Johnson in *The Historian and Historical Evidence* (New York, 1926). Paul Bonnefon, "Jean-Baptiste Rousseau et Lenglet du Fresnoy," *La Revue d'histoire littéraire de la France* (1900) 7 : 546–589, has presented a complete account of the quarrel between the two men. This article, however, is written entirely from the point of view of Rousseau and his friend Brossette, and Lenglet is made to appear in a strictly Machiavellian light.

Lenglet du Fresnoy was born in or about Paris the fifth of October, 1674.[2] At the age of twenty, in 1694, he took up the study of theology in Paris. During the second year of his studies, when the youthful clerk was living in the capacity of a servant with the Abbé Pirot, a doctor of the Sorbonne, a minor work launched him into the literary world and also placed him afoul of the police. In 1696 he published, with the Abbé Faydit, a treatise on the Virgin, in the *Lettre à messieurs les doyens, syndics et docteurs en théologie de la faculté de Paris sur le livre de Marie d'Agréda*. The theological ideas contained in this work were prohibited, and he was forced to make amends. A note on the records of the Bastille states that he was imprisoned in the same year for religious misdemeanors, but the details of this imprisonment are lacking.[3]

In 1700 Lenglet published the *Imitation de Jésus-Christ en forme de prières*, a work which was to remain exceedingly popular, and which went through many editions during the lifetime of the author.

Chance alone started him on his political and diplomatic career. In 1705 Monsieur Detorcy, minister of foreign affairs, sent him on a mission to the Elector of Cologne, who was then living at Lille. Lenglet chose to remain beside that prince, and giving up theology for politics, he took the position of First Secretary for Latin Languages at the Electoral Court. From this moment on

[2] The place of Lenglet's birth is uncertain. Michault, *op. cit.*, p. 21, gives Beauvais. Quérard, *op. cit.*, 5 : 158, names Paris. Lenglet himself gives us this one indication in the Preface of *De l'usage des Romans* (Amsterdam [*Rouen*], 1734) "Un voyage de long cours que je fis il y a quelque tems *à deux mil pas de lieu de ma naissance*, m'ayant procuré quelques mois de loisir, je me suis apliqué à diverses choses. . . . Dès que je fus embarqué, j'arrangeai mon tems . . . je ne rendois pas visite, j'en recevois très-peu. Le Capitaine et le Lieutenant de notre vaisseau auroient été Prieurs de Chartreux, ils n'auroient pas fait plus régulièrement observer le silence. Je me dis à moi-même, ceci peut durer, taillons-nous de l'ouvrage, six mois, un an, qu'importe! . . . au retour de mon voyage qui a fini le 20 juin, 1726." It was Lenglet's custom to call his sojourns in the Bastille *voyages*. A note on the police records shows that he was released from that institution the twenty-fifth of June, 1726, after being imprisoned since the twenty-eighth of June, 1725 (Bonnefon, *op. cit.*, p. 547). If Lenglet's statement is correct, he was born in the neighborhood of the Bastille.

[3] Bonnefon, *op. cit.*, p. 547.

his time was to be occupied chiefly by politics, literature, and history.

During his residence in Lille Lenglet did not neglect the development of his writing, especially that of a polemical nature. We have from his pen in 1707 *Deux lettres d'un chanoine de Lille à un docteur de Sorbonne au sujet d'une prière hérétique faite par un curé de Lille pour l'électeur de Cologne*, and in the following year the *Traité historique et dogmatique du secret inviolable de la confession*. This last volume was to prove so popular that a new edition, with a supplement of 109 pages, was published in 1713 and was again reprinted in 1715. Lenglet himself speaks rather vaguely about an edition of 1733. While a member of the Electoral Court he had opportunity to render an important service to the Elector by the discovery of a plot in which the captain of a gate at Mons was to give up the city as well as the electors of Cologne and Bavaria, who were there at the time. By his conduct in this affair he demonstrated an ability which was to make him useful later on to princes and ministers far more powerful than the Elector of Cologne.

At the time of the capture of Lille by Prince Eugene, Lenglet left the service of the Elector for the service of the victor. He was given a safe-conduct for all the possessions of the Electoral Crown. He made himself valuable to Prince Eugene in a literary way, chiefly through the purchase of books and manuscripts for the Prince's library.[4] Most of his time appears to have been spent in Paris, where he was quite well known as a man of letters.[5] An examination of the chronological record of his various works and editions shows that the period of ten years between 1708 and 1718 is the first of three prolific decades of writing.

In 1711 Lenglet published the *Mémoires sur la collation des canonicats de l'Église Cathédrale de Tournay, par les États-Généraux*. The demand for this work was so great that it was republished in 1712 and 1713.

Reëditions of this work did not occupy Lenglet's time, how-

[4] Ravaisson, François, *Archives de la Bastille, documents inédits* (Paris, A. Durand et Pedone-Lauriel, 1881), 12: 95. Cardinal Dubois to Count du Bourg.

[5] *Ibid.*, p. 95.

ever, and in 1713 there appeared the first edition of the *Méthode pour étudier l'histoire, avec un catalogue des principaux historiens et des remarques sur la bonté de leurs ouvrages et sur le choix des meilleures éditions.* It was a small work, two volumes in duodecimo, published by Coustellier. The success of the *Méthode* was instantaneous. A pirate edition, which copied the Parisian edition to the letter, appeared in Holland within a few months.[6] This was followed by an edition in Leipzig in 1714, which contained additions to the catalog by the German historian, Mencke.[7] The continued demand for the *Méthode* caused Lenglet to decide to publish an enlarged and revised edition,[8] but since he was unable to devote his attention to the work, the first edition was simply reprinted in Paris by Hochereau in 1716. This time the *Méthode* appeared in four volumes, in duodecimo. The year 1716 also witnessed the publication of an Italian translation, by Sebastian Coleti. Owing to Lenglet's liberalism, this edition was banned in Rome, but it was finally published in Venice, where it was augmented by a treatise on medals and inscriptions by Count Scipio Maffei.[9]

The frequent reprintings of the *Méthode* may be taken as an index of its popularity; the work was extremely well received by the critics. In December, 1713, an unsigned review of the newly published *Méthode* appeared in the *Journal de Trévoux.*[10] The article simply presented a summary, but Lenglet was commended for having attempted to remedy the troubles encountered in the study of history, which until that time had been the least regulated of subjects. The anonymous critic stated that it was to Lenglet's credit that he had tried to present a method which would be of service to those who read for pleasure alone as well

[6] *Mémoires pour l'histoire des sciences et des beaux-arts*, commonly designated as *Journal de Trévoux*, September, 1714, p. 1665. "Nouvelles littéraires."

[7] *Ibid.*, p. 1665.

[8] *Ibid.*, pp. 1665–1667.

[9] Lenglet du Fresnoy, *A New Method for Studying History*, translated from the French by Richard Rawlinson (London, Chas. Davis, 1730), Preface to Reader.

[10] *Journal de Trévoux*, December, 1713, p. 2031. "La Méthode pour l'histoire."

as to those who had serious study in mind.[11] His remarks on historians also elicited excellent commendation on his critical ability. "Quoiqu'il soit trop décisif et que ses décisions ne soient pas infaillibles, sa critique est ordinairement juste et souvent délicate." [12] Only twice in the course of the article was he mildly criticized. The extensive catalog at the end of the *Méthode* also received hearty approval and again furnished the opportunity for complimenting Lenglet, who had displayed "Une grande connaissance de livres, talent que distingue l'auteur, a rendu ces catalogues plus exacts que tous ceux qui ont paru jusqu'à présent." [13] With the exception of the two minor points, the review of the first edition of the *Méthode* was entirely favorable. This is indeed unusual, considering the remarks which Lenglet had made about contemporary historians.

Yet there is an excellent reason for the favor of the reviewer. He happens to be Lenglet himself. At the time when the article was written it was the policy of the *Journal de Trévoux* to have the authors of newly published works write summaries of them for publication in that paper.[14] The style of the unnamed critic and that of Lenglet correspond exactly. Furthermore, at the end of the article Lenglet is not blamed for any faults or opinions which appear in the edition. These are laid to the credit of those who published the first edition in Holland.[15] No such edition ever existed. It may be assumed, therefore, in light of the preceding facts, that Lenglet, with his well-known ability to escape blame, was simply preparing a means of avoiding criticism should the work be ill received.

This loophole, however, was not needed. The popularity of the *Méthode* became so great that Lenglet wrote to the editors of the *Journal de Trévoux* concerning his plans for a new edition.[16] In this letter he stated that the success of the *Méthode*, owing to the avid buying of the public, had given him the idea of putting out a new and more extensive edition. He had also

[11] *Journal de Trévoux*, p. 2032. [12] *Ibid.*, p. 2042. [13] *Ibid.*, p. 2048.
[14] Hatin, Eugène, *Histoire de la presse en France* (Paris, 1859) 2 : 260–265.
[15] *Journal de Trévoux*, December, 1713, p. 2048.
[16] *Ibid.*, September, 1714, pp. 1665–1668.

examined for corrected faults and additions the copies published in Brussels and in Germany. He made it clear that he was not responsible for whatever had been added to the "Bruxelles" edition, nor would he include Père Rapin's advice on the writing of history simply to swell the volume. But Lenglet was very grateful to Mencke for the useful additions and corrections to the catalogs at the end of the second volume.[17] With a gesture which was unusual for his age, he invited all other savants to aid him in this work. He welcomed their remarks and observations and promised that he would defer to their criticisms with a great deal of pleasure. But the hazards of his adventurous life did not permit him to make the projected revision until 1729.

From history the versatile Lenglet turned his attention to geography and in 1716 he published his *Méthode pour étudier la géographie*. This work purported to be founded on observations of the French Academy and on original authors. It contained a preliminary discussion of the manner of studying the science of geography, together with a catalog of maps, travels, and descriptions necessary for that science. In fact, this work was not exactly original. The first edition was based on the new *Géographie* of Père Martineau du Plessis, which had been rearranged and corrected by Lenglet.[18]

The literary productions of Lenglet ceased abruptly in 1718 with the publication in Amsterdam of a new edition of his *Méthode pour la géographie*. He became a spy of the Regent and was instrumental in discovering the guilt of those connected with the conspiracy of Prince Cellamare.[18a]

Lenglet's conduct in this affair was open to question, and the means which he employed were not considered those of an

[17] *Journal de Trévoux*, pp. 1665–1666.

[18] Lenglet du Fresnoy, *Méthode pour étudier la géographie* (Paris, 1742), 1 : iii, "Avertissement."

[18a] Lenglet was twice imprisoned in 1718: the first time from September 15 to perhaps the end of October, because of a *mémoire* presented to the Duke de Bourbon (Delort, *op. cit.*, 2 : 45, and Jean Buvat, *Journal de la régence* [Paris, Plon, 1865], 1 : 335); the second time from December 9, 1718, to December, 1719, with no reason given (Ravaisson, *op. cit.*, 13 : 213). Delort, believing Lenglet's imprisonment continuous, considered his participation in the Cellamare plot impossible.

honest man. Late in the year 1718 he assumed the position of a *mouton* and was introduced into the Bastille as the pretended author of a pamphlet in favor of the Duke du Maine. In this capacity he had no trouble in gaining the confidence of those who had been arrested for the same cause, and at the proper moment he provided the necessary evidence for conviction. It is said that he assumed this dishonorable task only after being assured that no one convicted on his evidence would suffer the death penalty. He himself was ashamed of this stain on his reputation and spent the rest of his life trying to efface it by works of erudition.

After this episode Lenglet continued his work as the literary agent and librarian of Prince Eugene. His occupation brought him into continual contact with men of letters [19] and finally led him to Vienna in December, 1721,[20] where he made some additions to the library of Prince Eugene. At this time he first made the acquaintance of Jean-Baptiste Rousseau.[21] Their contacts in Vienna were to lead to their bitter quarrel some eight years later. As for the rest, Lenglet seemed to have conducted himself wisely in Vienna, but in a manner which the Cardinal Dubois considered equivocal and which caused him to be suspected by the French authorities.[22]

Lenglet left Vienna the twelfth of April, 1722. He was traveling in a two-seated *chaise* and had a lackey mounted on a horse. As a companion he had a young girl, the sister-in-law of an artist of Lorraine, whom he was escorting to Lunéville. In his baggage he had some morocco for bookbinding, glasswork from Bohemia, his books, and certain papers which were desired for inspection by the Court of France. He is supposed to have reached Strasbourg on the eighteenth of April, where he lodged at the "Boeuf-Rouge." At this place he was arrested by order of Cardinal Dubois on the evening of the thirteenth of May.[23]

Cardinal Dubois in ordering the arrest of Lenglet gave the

[19] Ravaisson, *op. cit.*, 12 : 95.

[20] Lenglet du Fresnoy, *Histoire de Jeanne d'Arc* (Paris, 1753), Preface, p. xvi.

[21] French poet and versifier, contemporary with Lenglet.

[22] Ravaisson, *op. cit.*, 12 : 95. Dubois to du Bourg.

[23] *Ibid.*, p. 97. Du Bourg to Dubois, May 14, 1722.

following reasons: "S. A. R. désire extrêmement de faire arrêter cet abbé pour découvrir de quoi il pourroit être chargé à Vienne et quelle a été la cause du voyage furtif qu'il a fait." [24] In any case the arrest of Lenglet was so delayed that he had sufficient time to forward or dispose of any papers which he might have had in his possession.

The cause of his *voyage furtif* can be explained by the fact that he had very little money. He had made various attempts to leave Vienna, even to the extent of asking to travel to Holland with Rousseau, but on this occasion he received a flat refusal.[25] It is then probable that he undertook to return the young lady to France in exchange for the payment of his expenses. When arrested he owed the innkeeper of the "Bœuf-Rouge" a "louis d'or," which had been borrowed on the security of his baggage.

Lenglet was to be detained in prison and to have absolutely no communication with the outside world; nor was any one to be told why he was detained. His personal effects were to be searched; all letters and papers were to be seized, listed, and sent to Cardinal Dubois under seal.[26] As a result of these orders Lenglet was taken to the fort of "La Porte de Pierre," placed in *une bonne chambre* and kept there always under the sight of a guard.[27] Count du Bourg himself, aided by one of his lieutenants, faithfully carried out the instructions relating to Lenglet's papers.

Through his correspondence Count du Bourg showed himself an able assistant to Cardinal Dubois. The Count questioned Lenglet minutely on all points suggested by the Cardinal. Lenglet seemed eager to give any necessary information, but he had nothing of value to relate. "J'ai eu hier une conférence de deux heures avec l'abbé Lenglet du Fresnoy, que j'ai trouvé très-bien intentionné et soumis à exécuter toutes vos volontés. . . . Il n'a pas eu d'affaires importantes à négocier avec M. le Prince Eugène. Il m'a assuré de ne point connoître le duc de Noailles, et de même qu'il ne lui a jamais fait parler par qui que ce soit," wrote Count du Bourg on the sixteenth of July, 1722.[28]

[24] Ravaisson, *op. cit.*, p. 96.
[25] Bonnefon, *op. cit.*, p. 552. Letter of Rousseau.
[26] Ravaisson, *op. cit.*, 12 : 96. [27] *Ibid.*, p. 98. [28] *Ibid.*, p. 99.

In spite of his protest Lenglet remained suspected of a connection with the diplomatic intrigues of Prince Eugene. The young lady who was Lenglet's traveling companion continued her trip to Lunéville, and the lackey, after being searched, disappeared, while Lenglet himself continued to languish in the fort at Strasbourg. With no money and no prospect of release he made an attempt to escape. On the evening of the fifth of July he contrived to evade his guard and left the room where he had been confined. He was discovered the following morning, however, shivering in a corner of the fort and waiting for the gates to open.[29]

Count du Bourg was continually anxious about the welfare of his prisoner, especially in the matter of money. Since Lenglet did not have a sou to pay for his sustenance, the Count was afraid that he would starve to death. In every letter to Cardinal Dubois, du Bourg forcefully mentioned this matter. At last, in desperation, he suggested that Lenglet be taken to Paris for questioning. This could be done at very small expense, he stated, and concluded his letter with the hopeful thought that Lenglet might be of use to his Highness.[30] Du Bourg's suggestion seems to have had effect, for shortly afterward Lenglet was sent to Paris where, after furnishing the desired information, he was released.

From this time until 1729 Lenglet was not extremely active in the literary world. He stated that during these years he was attached to M. le Blanc, the minister of war, "M. le Blanc, auquel j'ai été si utile et si fidèle pendant plus de 20 ans, depuis 1708 jusqu'à sa mort en 1728. Je puis dire même que je n'ai pas peu contribué par mon zèle à lui sauver la vie et l'honneur en 1724 et 1725, et le tout avec un désintéressement de ma part qui peut-être n'a pas d'exemple." [31] In view of the fact that this letter was written nearly thirty years later, Lenglet was perhaps exaggerating his usefulness and even turning the facts to his own advantage. He was imprisoned for a short time in the Château of Vincennes in 1724,[32] and from the twenty-eighth of June, 1725,

[29] Ravaisson, *op. cit.*, p. 99. [30] *Ibid.*, p. 100.

[31] *Ibid.*, p. 375. Letter of Lenglet to Berryer.

[32] Barthélemy, Ch., "Deux lettres inédites de Lenglet du Fresnoy," *Bulletins de la Société des Antiquaires de Picardie*, 1850–52, p. 149; Delort, *op. cit.*, 2 : 75. Lenglet was transferred from Vincennes to the Bastille.

to the twenty-fifth of June, 1726, his days were spent in the Bastille.[33] The imprisonment of 1724 was caused by the publication of a seditious *Mémoire* against the government and the Ministers of France, and there is no evidence to show that Lenglet again played the rôle of a *mouton*.

The decade between 1729 and 1739 was one of the most prolific in Lenglet's life. During this period he saw sixteen editions of his various works through the press and, moreover, gave the energy of five of these years to bring to a successful but inglorious end his bitter quarrel with Jean-Baptiste Rousseau. In the year 1729 he published a pamphlet entitled *La Description de la fête et du feu d'artifice des ambassadeurs d'Espagne pour la naissance de M. le Dauphin*. This was followed in 1730 by the translation of a Roman prayer book into French, which he published anonymously, and in 1731 he brought out *La Cantanoise, ou l'histoire secrète des mouvements arrivés au royaume de Naples sous la Reine Jeanne*. Lenglet's greatest work, however, during these years was the long promised revision of the *Méthode pour l'histoire*.

It finally appeared in 1729. Undoubtedly he made the numerous additions and corrections to the 1713 edition during his several imprisonments between 1718 and 1726. This edition of 1729 was illegally published by subscription in Paris by Gandouin. The trouble caused by the censors incident to the publication was settled by the Marquis of Santa Cruz de Marsenado, the Spanish ambassador to the Council of Soissons. The revised *Méthode pour l'histoire* was composed of four large volumes in quarto, each volume containing approximately 550 pages (volumes III and IV being simply bibliography). There were three reprintings of the 1729 edition, two in 1735 and another in 1737. In addition, a *Supplément* to the *Méthode* came out in 1741. None of the later editions has the value of the original 1729 edition, since they have undergone severe mutilations by the censors. England was the last country into which a translation of the *Méthode* was introduced. Richard Rawlinson published an English version of the 1729 edition in 1730. It was printed in London by Charles Davis and consisted of two volumes in duodecimo.

[33] Bonnefon, *op. cit.*, p. 547.

The last edition of the *Méthode pour l'histoire* made its appearance in 1772. Drouet, *bibliothécaire de l'ordre des avocats*, augmented the catalog to such an extent that it became, according to M. Beuchot, the most complete in France.[34] The numerous reprintings of the *Méthode pour étudier l'histoire* show that it did fulfill an evident need in the already crowded field of historical methods.[35]

Scarcely had the revised and corrected edition of 1729 come from the press when it met with severe clerical criticism in the *Journal de Trévoux* for November, 1729.[36] Lenglet was immediately taken to task for having dared to publish the edition by subscription when such action was forbidden by the censors. He was told forthwith that he did not know his subject, and was soundly scolded and considered a *libertin* because of his views on religious history. As a criticism of the *Méthode pour l'histoire* the article is valueless. The manner of presentation, the general tone, and the thought expressed show plainly that it was the result of the righteous wrath of an outraged cleric, rather than a just and meditated criticism.

A very impartial reply to this article was not long in its appearance. The January number of the *Journal de Trévoux* for 1730 contained a *Justification* of Lenglet by an unknown author.[37] This critic asserted that justice must be done to Lenglet, and that faults he had not committed should not be left attributed to his name. Although the critic confirmed Lenglet's statements of several historical facts, he remained in the end doubtful of Lenglet's religious position.

Lenglet's own reply to the defamatory attack did not appear until October, 1730.[38] His article displayed none of the passion

[34] Quérard, *op. cit.*, 5 : 158.

[35] A detailed analysis of the *Méthode pour étudier l'histoire* and its place in the scientific development of the study of history in the eighteenth century is the subject of a forthcoming paper.

[36] P. 1987; "Mémoire adressé aux auteurs des Mémoires de Trévoux sur la Méthode pour étudier l'Histoire par M. l'Abbé Lenglet du Fresnoy."

[37] *Journal de Trévoux*, January, 1730, p. 175; "Justification de M. Lenglet du Frénoy au sujet d'un Mémoire sur la Méthode pour étudier l'Histoire, inséré dans ceux de Trévoux de Novembre 1729."

[38] *Ibid.*, October, 1730, p. 1750; "Mémoire adressé au R. P. H. par M. l'Abbé Lenglet du Fresnoy."

which characterized the attack of the preceding November. He immediately assumed the position that the question was not a literary or a historical dispute. For him it was a question of calumny in an essential matter, for a catholic theologian had been accused not only of erring from the faith, but of favoring *libertins*. Hence Lenglet defended himself in matters of religion only. He conserved the same haughty attitude at the end of his article as at the commencement. Admittedly he could not agree with many other points in the reverend cleric's criticism, but he believed that they should be best passed over in silence. With the publication of Lenglet's reply the *Méthode pour étudier l'histoire* passed from general public discussion, for his energies from that moment on were spent chiefly in attacking Jean-Baptiste Rousseau and in defending himself from the latter's counter thrusts.

Lenglet had never forgiven Rousseau for his insults during that winter in Vienna. In order to revenge himself, he conceived the idea of publishing, at the head of a new edition of the poems of Regnier, a defamatory epistle entitled the *Éloge historique de M. Rousseau*. Moreover, Lenglet was going to sign this epistle with the name of Claude Brossette, man of letters and librarian of the city of Lyon, who was a warm friend and correspondent of Rousseau. This edition was to be published in Amsterdam, and in 1731 Lenglet was in that city and planned to supervise its publication. But upon hearing that Rousseau knew what was taking place, Lenglet thought it safer to operate from France and immediately returned to Paris.

Thoroughly aroused, Rousseau acted quickly. He applied to his powerful friends and to several ambassadors to Holland, even daring, although exiled, to apply to M. Fénelon, the French ambassador. As a result, the edition was suppressed, and Lenglet was left to receive the scorn of the literary public. He was forced to write a letter of apology to Brossette. Lenglet acknowledged his fault and said that should the *Éloge* be published it would be done under his own name, and should any of the forbidden copies reach France, Brossette was empowered to state the truth of the matter in any journal whatsoever.

This check only served to fire the determination of Lenglet.

Late in 1732 he attempted to publish the *Éloge* as a *libelle;* it was seized and the circulation stopped. He was called before the police commissioner, M. Hérault, who "lui a bien lavé la tête comme il le mérite." [39] Lenglet was forced to give up his only copy, demand pardon, and promise to see that the edition was not published in Holland. Perhaps the general public sentiment was expressed by the lawyer Marais in the words which he used to end a letter: "Voilà une indigne action qu'a faite l'Abbé Lenglet; il en est bien capable, il n'a fait que des trahisons en sa vie." [40]

Undaunted, Lenglet went to even greater lengths to accomplish his design. With the connivance of a printer of Rouen he published secretly in 1734 *De l'usage des romans,* a satirical work stressing the value and pleasure of the most fanciful novels, followed by a bibliographical compilation of the type which he was accustomed to prepare during his *voyages* in the Bastille. The title-page stated that it was published in "Amsterdam, chez la veuve de Poilras à la Vérité sans fard." Although Quérard states that the edition was printed in Paris, Brossette in his letter to Rousseau of February 2, 1734, believed that it was printed in Rouen.[41] The *Usage* contained at the end the *Éloge historique de M. Rousseau,* together with Lenglet's letter to Fénelon, written at the very beginning of the attempt to publish the *Éloge.* Although Lenglet finally succeeded in publishing it, his efforts in that direction were more to his discredit than to his honor. One would like to think that the energy wasted in this matter could have been put to a more justifiable use than the expression of a spiteful hatred. The quarrel, however, had one curious result. Lenglet had succeeded in publishing in France, the country of literary repression, a manuscript which had been forbidden in Holland, the traditional home of a liberal press.[42]

The Abbé Lenglet was immediately recognized as being the author of the *Usage.* He denied it, however, and to make his

[39] Ravaisson, *op. cit.*, 12 : 146. Letter of Marais to President Bouhier.
[40] *Ibid.*, p. 146.
[41] Bonnefon, *op. cit.*, p. 584.
[42] The whole history of this affair is taken up in the article of Paul Bonnefon (*op. cit.*, p. 546).

denial emphatic he set out to publish under his own name *L'Histoire justifiée contre les romans*, a book which pedantically opposed the thesis of the *Usage*. *L'Histoire justifiée* appeared in Amsterdam in 1735.

For the next three years Lenglet was extremely active, not only in the field of literature but also in the field of education. In 1736 he edited the *Principes de l'histoire pour l'éducation de la jeunesse*. This work was reprinted in 1743 and 1752. In the same year (1736) he also published his *Géographie des enfans*, which was to prove one of the most popular works of its type. Two years later it was reëdited in question-and-answer form. Lenglet's death did not put an end to the popularity of this *Géographie*. It reached its seventh edition in 1766, and this was followed by four others in 1802, 1811, 1813, and 1817.

From the thought which he had given to the *Usage des romans* and the *Histoire justifiée* Lenglet conceived the idea of a serious work on the novel, to be done in the same manner as his *Méthode pour l'histoire* and the *Méthode pour la géographie*. He presented the plan for this work in the *De l'usage et choix de livres pour l'étude des belles lettres, avec des catalogues raisonnés des auteurs. . . .* This small book of twenty-two pages appeared in 1736, but the project was never completed. Literary and religious disputes occupied his time. He answered a letter of the Abbé Desfontaines on the subject of the *Méthode pour étudier la géographie*, and this answer in turn brought a reply by Père Chouseil, to which Lenglet responded by a new *Mémoire*. Both of these are reproduced in the *Traité historique et dogmatique des apparitions* of 1751. After this dispute Lenglet published nothing except the *Supplément* to the *Méthode pour l'histoire* until he edited *La Messe des fidèles, avec des maximes de pères* in 1742. During the same year a small volume entitled *Epître à Dom Matthéo Egittio, bibliothécaire du roi des Deux Siciles* came from the press, and this was followed by a more extensive work, the *Histoire de la philosophie hermétique*, which was accompanied by one of the compilations of which he was so fond. This work did not prove popular, however, and only the edition of 1742 and a pirate edition of the same year are recorded.

During March of the following year Lenglet had the misfortune

to displease the censors and the police for the fourth time. He was editing a supplement to the works of the historian, De Thou, and he inserted in it prohibited matter. A terse note on the police register by M. Duval, the secretary to the lieutenant of the police, reveals the extent of Lenglet's crime: "L'Abbé Lenglet du Fresnoy — — Rollin, libraire. Le premier a composé un ouvrage dans lequel il a, malgré les défenses de M. le Chancelier, inséré une addition que ce magistrat avoit prohibée, et Rollin a eu part à cette infidélité." [43] The order for Lenglet's entrance into the Bastille was dated the eighteenth of March, 1743, and he remained imprisoned until the eighth of June of the same year.

This arrest caused considerable stir among the men of letters in Paris, not only because of Lenglet's advanced age, but also because the work which he was editing was well known and had been through many editions. Even Voltaire was moved to comment on Lenglet's imprisonment: "Les lettres sont ici plus persécutées que favorisées. On vient de mettre à la Bastille l'Abbé Lenglet pour avoir publié des mémoires déjà connus, qui servent de supplément à l'Histoire de M. de Thou. Il a rendu un très grand service aux bons citoyens et aux amateurs de recherches sur l'histoire: il méritait des récompenses et on l'imprisonne à l'âge de soixante-huit ans." [44]

Lenglet protested vigorously against his detention, although the reasons which he gave for demanding his liberty are childlike in their simplicity. He complained that he was being ruined by having to pay for an apartment which he could not occupy; he must pay some insurance money at the Hôtel de Ville; he had editions coming out at two booksellers, and it was not just that they suffer because of his imprisonment. Finally, he asked for some softening of the rigors of his confinement.[45] This protest, however, seemed to have been effective, for a note at the bottom of the letter states that it had been agreed with the M. le Chancelier that Lenglet would be freed at Pentecost.

On leaving the Bastille in June, at the age of sixty-eight years,

[43] Ravaisson, *op. cit.*, 12 : 237. Note of Duval.
[44] *Ibid.*, p. 237, note. Letter of Voltaire, April 4, 1743.
[45] *Ibid.*, p. 241. Letter of Lenglet to Marville, May 14, 1743.

Lenglet entered upon the last and most fruitful period of his career. During the twelve years which were to elapse before his death, he was to publish nineteen major works under his own name, without counting those of which he was merely the editor, or to which he contributed a preface. He held himself continually abreast of current affairs, and in 1744 edited a volume called *Lettres, négociations et pièces secrètes pour servir à l'histoire des Provinces-Unies, et de la guerre présente.* These letters were taken from those of Van Hoe, the minister from Holland, which were written in 1743. How they came into Lenglet's possession remains a question. A surreptitious edition of the work, supposedly from London but printed in Paris, also came out during the same year.

The *Tablettes chronologiques de l'histoire universelle* were also revised and reëdited during the year 1744. This work continued to prove popular and was reprinted regularly until 1778. Another revision is also known to have been published in Geneva as late as 1808.

Under the pseudonym "Edouard Melton," Lenglet continued to evade the censors and to give his views on current affairs in Europe. The *Lettres d'un pair de la Grande Bretagne à Milord archevêque de Cantorbéry* pretended to be a translation from the English, but they were actually from the pen of Lenglet in 1745.

Yet even his advanced years did not keep him from meddling in the intrigues of the period. In a letter of the fourteenth of October, 1748, he made the following guarded remarks to an unknown correspondent: "J'ai l'honneur de vous envoyer quatre pièces que j'ai eu ce matin seulement. Vous y remarquerez la vérité de ce que je vous ai marqué jeudi dernier. Je me flatte que la direction de cette affaire ne sortira de vos mains . . . mais au cas qu'on voulut faire quelque chose à mon préjudice, je prendrai la liberté de m'adresser à Monseigneur le duc d'Orléans, et je luy marquerois qu'on me veut inquietter pour avoir fait l'apologie de feu Son Altesse Royale." [46] This letter corresponds in tone and form to a letter sent to the Abbé de Vayrac, an agent of the Portuguese minister, during the time of the Rousseau affair,

[46] Barthélemy, *op. cit.*, pp. 149–150.

and in both of them we see Lenglet preparing a way of escape in case matters do not break in his favor.

But two years later the inept Lenglet was not so fortunate as to have a means of escape. This time he ran counter to the censors and the police for having published a little almanac under the title *Calendrier historique pour l'année 1750, où l'on trouve la généalogie de tous les princes de l'Europe.* His *voyage,* however, was short, for he seems to have been released through the offices of his sister,[47] a Madame de la Barre, the wife of an "auditeur des comptes." [48]

Lenglet was to enter the Bastille for the last time a little more than a year later, when he had reached the age of seventy-seven years. On this occasion the charge was serious, as shown by the note of the chief clerk, Duval, on the records of the Bastille: "Lenglet du Fresnoy, accusé et prévenu d'avoir écrit une lettre signée le chevalier de Lussan à M. le contrôleur général, par laquelle il lui marque qu'il a agi au détriment des revenues du Roi, qu'il a attaqué le peuple, c'est à dire le pauvre et le misérable; qu'il a engagé 500,000 livres des revenues du R. par des rentes héréditaires sur ses postes; qu'il a écarté 9 millions de revenues de S. M. pour la compagnie des Indes; qu'il a engagé le R. de 1,200,000 livres par la création des rentes viagères." [49] The order for Lenglet's arrest was issued the twenty-fifth of December, 1751, and four days later he began his last *voyage.* Perhaps because of the efforts of his sister, or the consideration of M. Berryer for his advanced age, Lenglet was released on the seventeenth of January of the following year.[50]

He was not greatly concerned over this last imprisonment. His chief efforts were to console his sister and to turn her attention to someone else than himself. Lenglet desired her to look after

[47] Ravaisson, *op. cit.*, 12 : 373. Letter of Lenglet to his sister.

[48] *Ibid.*, p. 98. Du Bourg to Dubois.

[49] *Ibid.*, 16 : 196.

[50] *Ibid.*, 12 : 373. In Volume 12 of the *Archives de la Bastille* the note explaining Lenglet's letters to his sister and to Berryer confuses the imprisonment of 1752 with that of 1750. Both letters show the mistake of the note: the one to his sister by remarking her efforts of two years before; the one to Berryer by Lenglet's acknowledgment of having offended the Minister at this time.

the woman who took care of his apartment, since he was unable to do anything for her. He begged his sister not to abandon this poor old servant who had been with him so long and who had never received a sou in wages, since she was attached to him through the love which she bore him for having once rendered a great service to her parents. She was strongly recommended to his sister as being very virtuous, well-poised, religious, exact in her accounts, and hating lies. He also displayed great concern for a little dog which he had in his apartment and which he desired his sister to give to someone.[51]

To Berryer, Lenglet adopted a very different tone. He complained that he was arrested on the twenty-ninth of December, and that for this reason he had lost three hundred livres which were to be paid to him from his *rentes de la ville* on the thirtieth of the month. Then becoming properly repentant he admitted his fault and stated that he was sorry; that he did not mean to defame anyone and that an important minister could not desire the loss of such an insignificant person. At the advanced age of seventy-eight he expressed the wish that he might be attached to the minister as he had been to M. le Blanc for twenty years. He then added a note on his personal affairs concerning the publication of a new edition of his *Méthode pour la géographie* and closed by begging indulgence for his faults.[52]

Thus ended Lenglet's last *voyage* to the institution which he must have known rather well. With the exception of those two weeks of confinement his last years were spent in continuous literary labor. The year 1751 saw the publication of the *Traité historique et dogmatique des apparitions*, the main part of which was supposedly written in 1697, and the following year he brought out a new edition of his *Traité de géographie par demandes et par réponses*. On the tenth of April, 1752, the censor approved Lenglet's plan for a huge work to be called *Plan de l'histoire générale et particulière de la monarchie françoise*. Three volumes of notes for this work were published in 1753, but none of the remaining seven were ever put into print. The *Histoire de Jeanne d'Arc* was originally intended as a part of the *Plan de l'histoire*

[51] Ravaisson, *op. cit.*, 12: 373. [52] *Ibid.*, pp. 374–375.

générale, but Lenglet, having inspected the seventeenth-century manuscript of Richer, which was about to be edited, decided that the subject needed a better treatment and a great deal of revision. Therefore he published his *Histoire de Jeanne d'Arc* as a separate work. It appeared in three parts, the first two at Paris in 1753 and the third at Orléans in 1754.

This small volume on Jeanne d'Arc holds the distinction of being the first published work to treat the heroine scientifically on the basis of documentary evidence. Though Lenglet examined, by his own admission, the manuscript of Richer,[53] it is not true, as Endore states,[54] that he depended on it alone for his material. He shows himself perfectly familiar with the documents concerning Jeanne d'Arc in treating the history of France in his *Méthode pour étudier l'histoire*,[55] which was published forty years before the *Histoire de Jeanne d'Arc*.

During the latter days of his life Lenglet gave himself over to the study of chemistry. It is said that he even sought the "philosopher's stone." As a result of this activity, he published in 1751 a translation from the Spanish of Alanzo Barba's *Métallurgie*. Chemistry, however, was only a means of relaxation from his literary efforts, which continued until the day of his death. He was considering at that time the publication of his *Mémoires*, which, if he had not twisted the facts too much, would undoubtedly have thrown a great deal of light on the various political events in which he was concerned.

Lenglet died suddenly on the sixteenth of January, 1755, at the age of eighty-one years. Like a soldier who prefers to die on the field of battle, Lenglet, whose chief occupation had been books and their authors, died with a book in his hand. Coming in that evening just before the supper hour, he sat down beside

[53] Lenglet du Fresnoy, *Histoire de Jeanne d'Arc*, 2 : 200.

[54] Endore, Guy, *The Sword of God* (New York, 1931), p. 462. Endore's statement is based on the work of Ireland, *Memoirs of Jeanne d'Arc*, 2 : 73, which, according to Endore, was taken from Berriat-Saint-Prix. The latter appears to have taken the word of the Abbé d'Artigny at its face value.

[55] Lenglet du Fresnoy, *Méthode pour étudier l'histoire* (Definitive edition, Paris, 1729, gr. in-4°), 2 : 267, 438–440. Also *Journal de Trévoux*, December, 1713, p. 2047.

the fire to glance over a copy of *Les Considérations sur les révolutions dans les arts*, by the Abbé de Méhégen. He fell asleep in his chair, rolled from it into the fireplace, where he struck his head on the stones. He was dead before help could reach him.

Despite the fact that the judgment of his contemporaries upon him is almost universally harsh, as an untiring worker Lenglet stands out above them all, with the possible exception of Voltaire. His determination and his will to work were his two most outstanding qualities, and wherever he was, at home, or in the prisons of the king, he continued to prepare the publications which occupied his life. So accustomed was he to being imprisoned that once, it is related, on seeing the police officer Tapin, Lenglet cried to his housekeeper: "Come, quick, my package of laundry and snuff." [56] He tells us that he began the *Usage des romans* on one of his *voyages*, and while confined in the Bastille in 1743 he is found interviewing his booksellers and continuing his work. Again in 1752, not knowing how long he was to remain in prison, he asked Berryer to see that the different volumes of his *Géographie*, then in the process of revision, were brought to him in order that he might continue his labors.

Undoubtedly it was his continuous literary study which formed the basis for his enormous erudition, for the education which he received in the seventeenth-century Parisian seminary could not have led him to the heights he attained without a great deal of unprejudiced reading and original thought. But, unfortunately, this self-acquired erudition, like his Latin, sometimes failed him and frequently led him into many errors which the critics of his time attributed to bad faith. His display of learning was more caustic than profound.[57] His writings breathed a biting and malignant spirit which fearlessly struck his contemporaries whenever he thought such action necessary. Openly he criticized the bad and defended the good, and he cannot be blamed, as a contemporary blamed him, for having read and approved of Protestant authors when they stated facts.[58] For the rest, as M. Bonnefon

[56] Barthélemy, *op. cit.*, p. 148.
[57] Bonnefon, *op. cit.*, p. 548.
[58] *Journal de Trévoux*, November, 1729, p. 2014.

says, it was Lenglet's absolute lack of personal morality which brought him into such bad repute.

Yet Bonnefon's judgment, "Faisant, moyennant récompense, tous les métiers, et mettant la plume au service de tous ceux qui voulaient bien payer, l'abbé était capable de toutes les mauvaises actions, et a commis à peu près toutes les trahisons et tous les méfaits dont il était capable," is too harsh. He sees Lenglet only through the eyes of the enemy, Rousseau, and forgets that Lenglet lived in an age when morality was frequently held in contempt; when authors still lived by the patronage of their pens; and when literary disputes were protracted by every possible means until the absolute destruction of one of the participants.

If Lenglet had any admirable quality, it was his love of independence, with the freedom to say what he wished to say, even though it cost him imprisonment in the end. Because of his talents and important connections he could have reached a very high place in diplomacy, but he declined all offers to attach himself strictly to Prince Eugene, to Cardinal Passionei, to the French secretary of state, and to M. le Blanc, the minister of war. On occasion he acted as agent for each of them, but he preferred to be able to write freely and think freely, and so refused to become bound to any of them. When an old man, he would not live in Paris with his wealthy sister, but maintained his independence to the last. As a tribute to this independence it can be said that more than forty works are due to these refusals.

Despite his enormous literary production Lenglet was never a rich man. Poverty was his constant companion throughout life. He earned his education by acting as the servant of the Abbé Pirot, a doctor of the Sorbonne; his departure from Vienna was delayed because he was without money, and he managed to make the return trip to France only by bringing with him the sister-in-law of a Lorraine artist; when arrested at Strasbourg, Count du Bourg informed Cardinal Dubois that Lenglet had even borrowed money from the innkeeper. During his imprisonment of 1743 he protested that he could not pay the rent for an apartment which was unoccupied, and again, when in the Bastille in 1752, he stated that his arrest forced him to lose money which

would have meant a great deal to him. The apartment which he occupied in his old age was comfortable, however. It was well furnished, and consisted of an antechamber, a large study with an alcove, and a second study, which also served as a bedroom.[59] In these modest quarters Lenglet reached the end of his career, alone, as he had begun it.

There is something grand and something extremely pathetic about the old man who, facing perhaps the last of his days in prison, asked his sister to care for his old housekeeper and his little dog. And a still greater revelation of his character is noted when, at the age of seventy-eight, he asked for a position of confidence beside the minister, feeling sure that he could serve S. A. R. as well as he formerly did M. le Blanc. In spite of all the opposition and all his troubles, his zeal for work was never diminished, nor were his spirits dampened. Many years after his death, after a gradual evolution, the ideas and ideals which he propounded in his *Méthode pour l'histoire* have been adopted, until, at the present time, there is scarcely a historical method in use which was not advocated by the Abbé Lenglet du Fresnoy.

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[59] Ravaisson, *op. cit.*, 12 : 375.

ENSENADA AND THE FRENCH ALLIANCE, 1752–1756

ERNEST G. HILDNER, Jr.

THE Peace of Aix-la-Chapelle, concluded in October, 1748, was far from satisfactory to any of the powers. Few of the disputed points which had caused the war were settled. "The renewal of the *asiento* for four years was a mere evasion of the disputes between England and Spain which had kindled the war in 1739. . . . The stage had been set for a great struggle between France and Great Britain in America and Asia, but the curtain had fallen before the first act had been completed. . . . And, finally, Europe had lost such measure of stability as had been given by the traditional grouping of the Great Powers." [1] The Treaty of 1750 between England and Spain removed the asiento from the realms of international discord by the abrogation of the contract in return for a money payment. The other difficulties between the two powers were not settled. There remained the questions of freedom of navigation in the seas of the Indies and the right to cut logwood in the bays of Campeche and Honduras, which the Spanish had never admitted.

Both England and France realized that the peace was merely a truce and that the curtain would soon rise on the second act, which would be decisive. In order to be more fully prepared both nations sought allies, especially Spain, who would be able to furnish money secured from the mines of Mexico and Peru, as well as a base for an attack on colonies in the Caribbean or on its periphery.

The French-born king of Spain, Philip V, died before the Peace of Aix-la-Chapelle had been signed and was succeeded by his

[1] Lodge, Sir Richard, *Studies in Eighteenth Century Diplomacy 1740–1748* (London, 1930), p. 410.

second son, Ferdinand VI, who had seen with disgust the sacrifices which had been made by Spain in the interest of the children of his stepmother, Elisabeth Farnese, and which had yielded no benefit to Spain. The unnecessary expenditure of life and treasure seems to have instilled in him a profound love of peace.[2] He was of a just and benign nature, but subject, as his father had been, to fits of melancholia, which sometimes made it difficult to conduct state affairs. No action was taken by this soverign without consulting the queen, Barbara of Braganza, daughter of the king of Portugal. She had the confidence of her husband, but never used her ascendancy over him for her own ends, as Elisabeth had done over his father. She was dominated by fear of poverty, and seconded the efforts of Ferdinand to build up the prosperity of the nation. She whole-heartedly supported his policy of neutrality and aided either the French or the English factions, in order to maintain an equilibrium between them.[3] The king felt he had done almost his whole duty by the appointment of ministers, to whom he gave wide powers to carry out their policies and duties. He was fortunate in his choice of men, and by having representatives from both the pro-English and the pro-French parties, preserved the balance necessary to maintain his cherished policy of neutrality.

The most powerful minister was the Marques of Ensenada who held the offices of War and Finance, and of Marine and Indies.[4] He was of humble family and had come to the notice of Patiño while serving as a junior clerk in the Department of Marine. From that time his rise had been rapid. Although vain and ostentatious in his personal tastes, he was a capable officer. He was the leader of the French party in Spain, not through any affection for that nation, but because he disliked the English. With the help of the court musician, Farinelli, and the king's confessor, Rábago, also of the French faction, he hoped to bring about a revival of the Family Compact.

[2] Lafuente, Modesto, *Historia general de España* (Madrid, 1857), XIX: 286.

[3] Coxe, William, *Memoirs of the Kings of Spain of the House of Bourbon* (London, 1813), IV : 21–22.

[4] Armstrong, Edward, *Elisabeth Farnese* (London, 1892), pp. 391–392.

His colleague was José de Carvajal y Lancaster, who held the portfolio of state. He was in every respect a contrast to Ensenada. He came from a long line of distinguished public servants and was proud to claim descent from the House of Lancaster. In manner he was stiff and uncompromising, so much so that he refused to make compliments to the sovereigns for fear it might appear that he was trying to curry favor with them.[5] He was favorably disposed toward England, but above all he was a Spaniard and loyally tried to carry out the desires of his king.

Benjamin Keene was the English minister at the Court of Madrid. Except for the period of the war, 1739–1748, he had held the appointment since 1727. Before that he had been British consul-general in the peninsula and agent of the South Sea Company to the king of Spain. His manner was agreeable to the Spanish and, owing to his long residence among them, he was well aquainted with the customs and habits as well as the prejudices of the nation. He was so well liked personally that on the outbreak of the War of Jenkins' Ear in 1739 the Spanish monarchs had expressed regret at his departure. He was opposed by the Duke of Duras, a distant relative of Noailles, who had been recommended by Ensenada. Duras was full of a bustling activity, impatient, vain, and with an imagination which pictured success from trifles.[6] These qualities were of importance at the Court in France, but were sadly out of place in Spain.

The first sign of a break in the relations of France and Spain, following the peace in 1748, was the negotiation of a treaty of alliance between Spain, Austria, and Sardinia to regulate affairs in the Italian Peninsula. The progress of the treaty was assisted by the English through the good offices of Keene. Ensenada tried by all the means at his disposal to prevent the acceptance of the treaty, or at least to have the French admitted among the contracting parties. His efforts were aided by the French king and Court, who called Ferdinand's attention to the fact that the Bourbons were all one family, that France had placed his father

[5] Garcia, Mariano Marfil, *Relaciones entre España y la Gran Bretaña* (Madrid, 1907), pp. 95–96.

[6] Coxe, *op. cit.*, pp. 65–66.

on the throne of Spain, and asked him to remember their constant alliance. In spite of all opposition the treaty of alliance was signed on June 14, 1752.[7] England, when the treaty had been completed, desired to become one of the signatory powers. Carvajal refused the request in order to avoid giving unnecessary offense to France or an appearance of undue British influence in the councils of Spain.

Charles, king of Napoles, the half-brother of Ferdinand and heir to the Spanish Crown, refused to recognize or adhere to the Treaty of 1752 and began a separate negotiation with the king of France. In addition, he made overtures to England in which he invited a minister to his Court in order to promote trade between the two nations. Great Britain refused to send a representative until permission had been secured from Their Catholic Majesties. This mode of procedure was pleasing to Spain and helped to promote cordial relations with England.[8] In the meantime Ferdinand had become displeased with his other half-brother, Philip, Duke of Parma. Philip had married the daughter of Louis XV and imitated in his dukedom the profusion and prodigality of Versailles, which soon resulted in innumerable debts. It was expected that the Spanish treasury would pay the bills, but Ferdinand refused the requests of his brother and would have nothing to do with him. Through the good offices of Duras and Grimaldi a reconciliation was effected which, however, was neither sincere nor lasting, since Philip, under French influence, refused to mend his ways and was soon once more asking Ferdinand to pay his debts. This incident was not helpful to French influence at the Spanish Court.

The French, in order to check the growing influence between England and Spain, endeavored to have Don Ricardo Wall, the Spanish minister in London, removed, and Grimaldi, who was less pro-English, appointed in his stead. Wall was of Irish stock and had become prominent in the Italian wars, in which he had served in the Spanish army. There he attracted the attention of Patiño, through whose influence he rose rapidly to the highest

[7] Cantillo, Alejandro del, *Tratados de paz y de comercio* (Madrid, 1843), pp. 412–415. Cf. Notas, pp. 415–416. [8] Lafuente, *op. cit.*, p. 306.

rank. While in attendance on the Spanish Court he became a close personal friend of Keene. Wall was sympathetic toward England and tried to promote a closer union of the two kingdoms.[9] To gain the adherence of Carvajal to the plan for the recall of Wall, Louis XV offered him membership in the Order of the Holy Ghost. At the same time the order was offered to Ensenada and his chief supporter, the Duke of Medina Celi, an ardent Francophile. Carvajal begged the permission of the king to refuse the honor. Ferdinand was so pleased by Carvajal's action that he ordered all the decorations returned to Louis. The offer had, in some measure, been prompted by the activities of Duras, who proposed a new Family Compact. The alliance was refused by Carvajal, as was one proposed by Keene not long afterward.

While European matters had been occupying the Spanish Court, the American questions had come to the fore in the relations with England. Complaints were made against British subjects who had settled on the coast of Central America for the purpose of cutting logwood. Protests were also made against illegal seizures of ships in those regions. The English, on their part, accused the Spanish of seizing vessels on the high seas without sufficient provocation. As a result of Keene's complaints over captures in America, Ensenada, early in 1751, promised to prepare a new series of regulations which would remove all causes for disputes over the right of navigation.[10] In May Keene was assured that the work of drafting the new regulations was under way, but would have to be approved by the Junta, of which Carvajal was a leading member. Ensenada told Keene that he believed the king might be induced to approve the regulations, in spite of the fact that they were not at all in harmony with the existing laws of the Indies.[11] The British Ministry regarded this as a promise and

[9] It is amusing to note that almost all Spanish authors attribute Wall's attitude toward England to his Irish birth.

[10] Wall to Carvajal: London, February 1, 1751. Archivo General de Simancas, Estado, legajo 2339, packet 6919. (Hereafter referred to as Simancas, with legajo and packet numbers following.)

[11] Keene to Bedford: Antigola, May 17, 1751. Public Record Office. State Papers 94, Foreign Spain. V : 139. Cipher. (Hereafter referred to as P.R.O., S.P. 94.)

in their letters to Keene insisted on the remittance of the scheme to London at the earliest possible date. Ensenada took his time in preparing the plan, and it was not until the following March that Keene was told the task had been completed. Carvajal received the papers relating to the project from Ensenada, but was totally disgusted with him and with them, for they were in such disorder that he was unable to make use of them. Keene was advised that, though this measure had failed, Carvajal would do all in his power to promote harmony between the two powers.[12]

In the meantime Keene had been soliciting orders for the return of prizes made after the signing of the cessation of hostilities in 1748. These commands had been promised and presumably had been sent. Complaints were soon received that the orders had not been obeyed, and Keene continued to demand that new ones should be forwarded to the officials in the New World. In April, 1752, Carvajal requested information on the subject from Ensenada, but no reply was made until the following month, when Ensenada declared that the orders had been sent and that the governors had complied with them.[13] Thereupon Keene, following the instructions he had received from home, endeavored to have the payment for ships which had not been restored made from the royal coffers. Ensenada promised to do his best, but it remained for Carvajal, although it was out of his jurisdiction, to secure satisfaction. He presented the plan to Their Catholic Majesties in a long conference in which it was pointed out that, if the matter was not settled, the result would be war with England. Spain would then be thrown into the arms of France, as had happened in the War of Jenkins' Ear, which had been caused by similar occurrences. With these considerations in mind it was decided that payment for ships illegally taken in the Indies should be made from the royal treasury. Ensenada was commanded to confer with Carvajal over the best method for the execution of the project.[14] This proved effective, for on July 3 Keene was given duplicates of the orders to be sent to the governors in

[12] Keene to Holdernesse: Madrid, March 22, 1752. *Ibid.*, V : 141.
[13] All this correspondence may be found in Simancas 2338, 6915.
[14] Keene to Holdernesse: June 30, 1752. P.R.O., S.P. 94, V : 142.

America. These stated that, if restitution was impossible in any other manner, it should be made from the royal chests in the port to which the prize had been taken. The governors were to be held responsible for the execution of the new regulations. Ensenada tried to conceal his British antipathy by telling Keene he wished even more could be done to satisfy the demands of England.[15]

By the next year the orders for restitution or payment seem to have been obeyed. Complaints of new captures were made, however, and Keene was directed to protest in the name of his government. Wall, in London, feared that these continued actions might bring on a new war and recommended to Carvajal that all commissions for cruisers should be recalled and the *guarda costas* limited to the immediate vicinity of the coasts they were supposed to protect. Keene wrote that the Spanish Court seemed to be disposed to make some reasonable settlement, especially since the French minister was busily engaged in trying to foment trouble by using the disputes with England in the Indies as the basis of his plots and intrigues.[16] In July Keene learned from Newcastle that the orders for restitution had not been obeyed at Havana, and he was commanded to make the strongest representations to the Spanish Court on the subject. Letters from Wall confirmed the statements which accused the governor of refusing to obey these orders. He also made the observation that in England little credit was given to the report that the orders had been dispatched.[17] After a conference with Carvajal Keene passed a memorial to him; when a favorable opportunity presented itself, it was delivered to Their Catholic Majesties. Keene commented that Ferdinand was inclined to give justice in the matter, but that Carvajal was the first Spanish minister who seemed to take the English protests to heart and tried to do something about them.[18] These efforts were successful, for renewed instructions were given by the monarch to have the orders obeyed in America.

[15] Keene to Newcastle: Madrid, March 1, 1753. *Ibid.*, V: 143. Private.
[16] Keene to Holdernesse: Madrid, March 1, 1753. *Ibid.*
[17] Wall to Carvajal: London, August 23, 1753. Simancas 2340, 6924.
[18] Keene to Newcastle: Madrid, August 23, 1753. P.R.O., S.P. 94, V: 144.

Their execution was intrusted to Ensenada, but was delayed, owing to his illness.[19]

Another unsettled matter seemed likely to cause a rift in the amicable relations between England and Spain. This was the dispute over the right to settle and cut logwood in the region of the Bay of Campeche and the Mosquito Coast. The right had long been claimed by the English, who had established considerable settlements in those parts. The Spanish declared that these were illegal and also contrary to all the existing treaties. As early as the midsummer of 1750 rumors were current in Anglo-America that the Spanish officials were preparing a force which would drive the English from the disputed territory. These rumors were circulated in Great Britain also, where some apprehension was felt for the safety of her nationals and the rights claimed over the area.[20] The suspicions were given more emphasis in the next year, when the English on the Mosquito Coast captured a vessel sent by the commander of Honduras to reconnoiter their position. The ship had been carrying dispatches, and Ensenada demanded a disavowal of the act by the English Government.[21] A few days earlier Carvajal had protested in much less harsh terms, although he was firm on the point that the lands were the possession of the king of Spain and that the British were interlopers.[22]

The following year Keene procured proof that some sort of attempt was to be made on the English settlements. The attack had been planned, and the leader, Don Pedro de Silva, disguised as a merchant, had made observations of the British strength.

[19] Keene to Holdernesse: Madrid, August 27, 1753. *Ibid.*

[20] Abreu to Carvajal: London, July 23, 30, and August 13, 1750. Simancas 2338, 6917. All in cipher. Also Abreu to Carvajal: October 1, 1750. *Ibid.*

[21] Ensenada to Wall: January 24, 1752. Archivo Histórico Nacional. Estado, legajo 4267. (Hereafter referred to as A.H.N.) "... en su vista me manda el Rey decir a V. E. no duda que esse Ministerio abra desaprovado y repreendido la conducta y infraccion cometida por el Patron de la citada Embarcazion en la aprecension de las citadas Pliegas como impropria del decoro que merecian y de la buena correspondencia y Armonia que subsiste entre los dos naciones."

[22] Carvajal to Abreu: January 10, 1752. *Ibid.*, 4277.

The project had been temporarily abandoned, owing to the death of De Silva, but his lieutenants were in Madrid, where they had presented petitions to be appointed in his place. This did not seem to alarm the English, but some naval preparations were made which furnished Duras with ammunition to make a break in the relations between the two powers. "My Busy Competitor [the French minister] has been persuading the Confessor that our military Preparations in England are designed against the French West Indies; & the Catholic King has told the Confessor what he knows to the contrary, so this weak Attempt has turned out to their Confusion." [23]

While these intrigues to gain Spain as an ally were at their height and the relations with England were still delicate, Carvajal fell ill and died, on April 8, 1754. The French faction was jubilant and the English were alarmed, for it was popularly supposed that Ensenada, in addition to his other offices, would be offered the ministry of state, or would secure it for his chief secretary, Ordeñana. The king, however, called the Duke of Huescar, later Duke of Alva, and the Count of Valparaiso, gentleman-in-waiting to the queen, into consultation. Both were of the pro-English party, and after Valparaiso had declined the office of state, which Ferdinand had offered him, Wall was suggested for the place and immediately recalled from London.[24] All this took place without the knowledge of Ensenada, who was thus unable to use the influence of the confessor or of Farinelli to persuade Their Majesties to his desires. A great many of his cabals died with the arrival of Wall in Madrid. The king gave his utmost confidence to Wall, whose friendship with Keene so increased that the pro-English faction was definitely in the ascendant.

Ensenada realized that his power was slipping and determined on extreme measures in order to gain his former place and oust his opponent. To secure his ends he felt it necessary to provoke a war between Great Britain and Spain. Pursuant to this plan, and unknown to his sovereign, he arranged an alliance with the

[23] Keene to Holdernesse: Madrid, March 11, 1754. P.R.O., S.P. 94, V: 146. Cipher.

[24] Lafuente, *op. cit.*, pp. 327–328.

French Court and made loans to the French East India Company to enable it to take the offensive against the English in that part of the world. These measures, if not made under the influence of the dowager queen, Elisabeth, yet had her tacit approval.[25] The English were also to be set in a bad light in Spain. Ensenada had all the complaints against the English in America collected and reported them to the king with great warmth. His Majesty was persuaded to refer them to a Junta, which in turn was induced to present a report, exaggerating the actions of the British, and urged the king to take measures for defense in America, as well as to demand redress from the English Government. Ensenada was unable to gain the consent of Ferdinand to the last article, so he planned, in conjunction with the French, a general attack upon the settlements on the coast of Central America.[26]

In the furtherance of this plot Ensenada sent secret orders to America for an attack upon the English, without the knowledge or consent of the king. Fortunately, Keene managed to get hold of some of the secret instructions and sent them to his court on June 17, 1754. He commented that, though he expected the expedition to fail, he feared it would raise a great clamor in England.[27] On the 19th of the next month he received an answer which directed him to protest vigorously against this project. He was able to show Wall and Huescar that the orders should be revoked immediately and convinced them that Ensenada should be removed from all his employments. Keene then furnished those ministers with a copy of the instructions sent to Havana, so that they might show the king the extent of the plot. As a result of an audience in which this was read, His Majesty determined upon the dismissal of Ensenada,[28] who was soon banished to Granada with a pension from the government.

The British Ministry, upon the receipt of the letter from Keene in which he told of the attack which had been planned on the settlements, ordered Admiral Knowles, governor of Jamaica,

[25] Armstrong, *op. cit.*, p. 393. [26] Coxe, *op. cit.*, pp. 120–123.

[27] Keene to Robinson: Antigola, June 17, 1754. P.R.O., S.P. 94, V : 147. Cipher.

[28] *Ibid.* July 31. Most secret No. 1.

to meet force with force.[29] The Spanish counterorders were not sent as promptly as Keene desired, but Wall excused himself on the ground that the papers of both Carvajal and Ensenada were in such confusion that he could make but little of them. He was forced to ask Keene for copies of letters which were missing from the files of those ministers.[30] The desired orders were sent about the middle of September. These instructed the governors to cease all their preparations for the attack, or, if it had already been launched, to stop as soon as the notices arrived.[31] With the arrival of these instructions in London similar directions were sent to Admiral Knowles. Along with the counterorders the Spanish Government sent cedulas to the governors enjoining them to obey those of July, 1752, which restored to the British all ships taken before that date. These earlier cedulas had never been enforced, owing to the influence of Ensenada. All precautions seemed to have been in vain, for early in December news arrived from New York that the Spanish had actually made attacks upon the British in Honduras and driven out the logwood cutters. Satisfaction for the action and restoration of the *status quo* was demanded by the English.[32] The report was soon confirmed and, after several conferences, the Spanish prepared orders commanding the return of all ships captured from the English. They flatly refused permission for the return of the logwood cutters to the places from which they had been driven, since that privilege had never been granted them by the king of Spain.[33] The British continued to insist that the Bay men should be allowed to return and resume their operations, but to this the Spanish turned a deaf ear.

The actions of Admiral Knowles had been very displeasing to Spain. The admiral, as a consequence of the attack, had entered upon an acrimonious correspondence with the governor

[29] Minute of the Privy Council: July 3, 1754. British Museum, Additional Manuscripts 33,019, p. 60.

[30] Keene to Robinson: Madrid, September 2, 1754. P.R.O., S.P. 94, V : 147. Cipher.

[31] Wall to Abreu: Buen Retiro, September 25, 1754. A.H.N., 4273.

[32] Robinson to Keene: December 12, 1754. P.R.O., S.P. 94, V : 147.

[33] Keene to Robinson: Madrid, January 12, 1755. *Ibid.*, V : 148. Secret and Confidential No. 2.

of Guatemala, in which he made various disparaging remarks anent the king of Spain and his ignorance of the actions in the Indies. This was resented by the governor, who took up the matter with Madrid.[34] Not long afterward Knowles, without waiting for instructions from home, sent an expedition which fortified the chief of the former settlements, at the mouth of the River Walis, and stationed a frigate to protect the logwood cutters. The Spaniards were alarmed by these actions, in spite of the efforts of Keene to show that all had been done without authority.[35] In November Knowles was reprimanded for his conduct at such a critical juncture. In February of the next year he was removed, and Shirley, governor of Massachusetts Bay, appointed his successor.

War between England and France had already begun in America with the capture of Washington and his small force on July 4, 1754. Duras tried to take advantage of the discord between the British and Spanish over Honduras to renew his efforts to form an alliance with Ferdinand. None of the ministers would consent to receive his offices.[36] He then resorted to seeking the favor and influence of Farinelli, who informed him that he was a musician, not a politician. Within a short time Madame Duras asked and received an audience with the queen, in the course of which a letter from Louis XV was produced. Louis requested Barbara to keep the matter from her husband, the king, and to maintain a personal correspondence with him in the French language. The letter was immediately placed before the king, in the presence of his ministers, and a formal reply was sent through the Spanish embassy in Paris. The ambassadress, ignorant of this action, asked for another audience, and when she was with the queen began to accuse the ministers, especially Wall, of being opposed to France and partial to England. Barbara soon silenced her and commanded her to refrain from mentioning the matter again.

When the news of the naval engagement off the coast of Newfoundland arrived, Duras again tried to persuade the king. He

[34] Keene to Holdernesse: Madrid, July 24, 1755. *Ibid.*, V : 149.
[35] Keene to Robinson: October 16, 1755. *Ibid.* Separate.
[36] Becker, Jeronimo, *España é Inglaterra* (Madrid, 1907), p. 30.

sought an audience in which he read a memorial that was quite vituperative against the English and suggested a new compact for the security of both branches of the Bourbon family. After reading the memorial, in another paper Duras accused the Spanish Ministry of keeping Ferdinand in ignorance of affairs in America, as well as in Spain itself. The king was indignant and desired the immediate recall of the minister, but was persuaded to give a moderate reply to the memorial, in which he declined to act as an arbiter between France and England, for Wall saw clearly that this was a trick of the French Court to cause a new disagreement with Britain. Within a short time the recall of Duras was demanded, and in October, 1755, he left Spain.[37]

In spite of the efforts to have him removed, Rábago, the confessor, still held his office. A short time after the recall of Duras, Keene, in concert with the Portuguese minister, Carvalho, later the Marques of Pombal, produced proof that Rábago had encouraged the Jesuits in Paraguay in their resistance to the treaties between Spain and Portugal which settled the limits of those possessions. Additional papers were shown which implicated him in the plot of Ensenada. These were enough for Ferdinand who, without consulting his ministers, commanded Rábago to return to his monastery in disgrace. With his dismissal the English party in Spain seemed triumphant.[38]

The seeming ascendency of England in Spanish affairs was of short duration. Most of the minor officers were still held by the partisans or appointees of Ensenada. The government of England under the guidance of Newcastle was too weak and vacillating to command respect abroad. The chief blow to British influence in Spain was the death, in 1756, of Keene, the only person who might have held the Catholic kings from the French interest. With the accession of Charles III in 1759 the French triumph was complete. Subsequently the Family Compact was signed, and Spain entered the war in 1762 as an ally of France.[39]

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[37] Lafuente, *op. cit.*, pp. 351–355. [38] Coxe, *op. cit.*, pp. 163–164.
[39] Arthur S. Aiton, "The Diplomacy of the Louisiana Cession," *American Historical Review*, 36: 701–712.

THE "LAME DUCK" AND CONGRESS

CHARLES W. SHULL

AFTER nine years of disagreement the House of Representatives and the Senate of the United States have proposed a constitutional amendment seeking to abolish the "lame-duck" or short session of Congress.[1] The Federal Constitution of 1787 provided for annual sessions of Congress, convening on the first Monday in December.[2] But the election date for members has been fixed as November of the even-numbered years, the effect being to leave in office and subject to assembly in December a congress elected for the most part two years before.

In view of the fact that this turnover in the membership occurs just prior to the short session, question may be raised as to the motives and conduct of these defeated or retiring members while engaged in completing their term. Popular opinion views with distrust and suspicion the presence of these individuals in the legislature. They are dubbed "lame ducks" in derision, pictured as such because, though grievously wounded by their recent defeat at the polls, they are yet able to hobble through the short session as fully empowered legislators. Not only is that accusation hurled against them; they are blamed for all the trials and tribulations that beset the course of legislation during the short session.[3]

In popular estimation the lame duck is the Senegambian in the woodpile, so far as the short session of Congress is concerned. The personal element bulks large, and since the defeated members are truly excellent targets, all the vituperative criticism is turned against them, whether or not they are in any way responsible for whatever good or evil comes out of the short session in which they

[1] *The New York Times*, February 28, 1932.

[2] See Article I, Section IV.

[3] See Senate Report 170, 68th Congress, 1st Session, for summary of arguments in favor of abolition.

still participate. If a filibuster develops in either house, it is the lame ducks who are damned; if bicameralism does not function with unanimity of opinion between both houses and the executive, the selfsame lame ducks are at fault. But *are* they at fault? one may ask. In what measure do they participate in the legislative processes of the nation? Have they been responsible for the distrust shown the national legislature?

The short session of the Seventy-first Congress convened in December of 1930.[4] In this session [5] were twelve members of the Senate who ceased their service in March, 1931: Blease of South Carolina, Deneen of Illinois, Gillett of Massachusetts, Goff of West Virginia, Gould of Maine, Heflin of Alabama, McMaster of South Dakota, Phipps of Colorado, Pine of Oklahoma, Ransdell of Louisiana, Simmons of North Carolina, and Steck of Iowa. Senators Gillett, Goff, Gould, and Phipps retired voluntarily. Blease, Deneen, Ransdell, and Simmons met defeat in the primaries; Heflin, barred from his party's primary in Alabama, was defeated in the general election when he ran as an independent; Pine, McMaster, and Steck also lost their seats in the November balloting.[6] Of these, Blease, Heflin, Ransdell, Simmons, and Steck were Democrats, the rest Republicans.

In the House of Representatives fourteen members retired voluntarily; six sought promotion to the Senate, three succeeding [7] and a like number being unsuccessful in their efforts. Consequently, the latter three, McCormick of Illinois, Fort of New Jersey, and Box of Texas, have been included in this study. Thirteen members of the House ended their congressional careers at the primaries, and forty-four met defeat as the result of the November elections. It is apparent, then, that for a group of eighty-six members the short session of the Seventy-first Congress was the last in which they served.

[4] This was the third session of this Seventy-first Congress.

[5] Macmahon, Arthur W., "Third Session of the Seventy-first Congress," *Am. Pol. Sci. Rev.*, 25 (1931) : 932–955. A survey of the activity of the session.

[6] These data are tabulated from the files of *The New York Times*, for 1930.

[7] Those promoted to the Senate by their success at polls were White of Maine, vice Gould; Hull of Tennessee, vice Brock, appointed to fill vacancy caused by death of Tyson; and Dickinson of Iowa, vice Steck.

Thirty-two of these lame ducks came from the North-central States, five from New England, fifteen from the Atlantic States, eight from the South, nine from the Southwest, thirteen from the Northwest, and four from the Pacific States. Senator Simmons had served as a North Carolina senator for thirty years; Ransdell of Louisiana had served eighteen years; Phipps of Colorado, twelve years; Heflin of Alabama, eleven years; Deneen, Blease, Gillett, Goff, McMaster, and Pine, a single term; Gould and Steck had been in the Senate for five years.[8] Three of these men had long service records in the lower branch of Congress: Gillett entered the House of Representatives in 1893 and served continuously until his election to the Senate in 1925, being Speaker from 1919 until his departure for the upper chamber; Ransdell made his début in the House in 1899; and Heflin came to Congress in 1904.

In the House of Representatives Bell of Georgia had served thirteen terms; Browne of Wisconsin and Cramton of Michigan, nine; three others, Dempsey of New York, Denison of Illinois, and Kearns of Ohio, had been in Congress for eight terms; Elliott of Indiana, Fisher of Tennessee, Miller of Washington, and Zihlman of Maryland, for seven. Six of these lame-duck Representatives had six terms apiece;[9] ten, five terms;[10] eight, four terms.[11] For eleven the short session of the Seventy-first Congress was the third term;[12] for seven, the second;[13] and for twenty-

[8] These data are assembled and tabulated from the information presented in the various editions of the *Congressional Directory* for the Seventy-first Congress.

[9] Box of Texas, Hickey of Indiana, Hudspeth of Texas, Moore of Virginia, O'Connor of Louisiana, Thompson of Ohio.

[10] Fenn of Connecticut, Fitzgerald of Ohio, Kunz of Illinois, Michaelson of Illinois, Morgan of Ohio, Reece of Tennessee, Speaks of Ohio, Sproul of Illinois, Ellis of Missouri, Sloan of Nebraska.

[11] Doyle of Illinois, Hudson of Michigan, Sears of Nebraska, Spearing of Louisiana, Sproul of Kansas, Wainwright of New York, Watres of Pennsylvania, Chalmers of Ohio.

[12] Brigham of Vermont, Fort of New Jersey, Hall of Indiana, Irwin of Illinois, Johnson of Indiana, Letts of Iowa, Menges of Pennsylvania, Rowbottom of Indiana, Stobbs of Massachusetts, Whitehead of Virginia, Dunbar of Indiana.

[13] Hoffman of New Jersey, Korell of Oregon, Langley of Kentucky, Oldfield of Arkansas, Esterly of Pennsylvania, Kiefner of Missouri, Wolverton of West Virginia.

two it was the first time they sat within the chamber of the House of Representatives and quite possibly it was to be the last.[14] Only eleven of the seventy-four lame ducks in the House of Representatives were Democrats.[15]

We now turn to an analysis of the record of these retiring members of the United States Senate and House of Representatives, as disclosed by the pages of the *Congressional Record*.[16]

What about the fidelity of these men in attending the sessions of their respective chambers? Were they notoriously lax in attendance or did they show marked interest in the legislative sessions, or, again, did they merely approximate the performance one might expect from any similar group in such circumstances?

During the session there were in the Senate 197 quorum calls whose sole purpose was to determine whether or not a majority of the membership was present. The twelve lame-duck Senators accumulated a grand total of 709 absences from such roll calls, as compared with a grand total of 1,455 entries of "present." The average number of absences was 59 for each Senator. Individually the number ranged from 11 for Heflin and 17 for Goff to 127 for Steck and 156 for Simmons.[17]

The situation is somewhat different in the House of Representatives, where we do not have a daily record of attendance like that which exists for the Senate. Only 52 general roll calls of the four hundred and thirty-five members were taken during the entire session; 19 were attendance or quorum calls. Here the seventy-four lame-duck members totaled 453 absences against

[14] Baird of Ohio, Blackburn of Kentucky, Clark of Maryland, Craddock of Kentucky, Garber of Virginia, Halsey of Missouri, Hull of Wisconsin, Johnson of Nebraska, Jonas of North Carolina, Kendall of Kentucky, McCormick of Illinois, Newhall of Kentucky, Johnston of Missouri, O'Connor of Oklahoma, Palmer of Missouri, Pritchard of North Carolina, Ramey of Illinois, Shaffer of Virginia, Short of Missouri, Simms of New Mexico, Stone of Oklahoma, Walker of Kentucky.

[15] Oldfield of Arkansas, Bell of Georgia, Doyle of Illinois, Kunz of Illinois, O'Connor of Louisiana, Spearing of Louisiana, Fisher of Tennessee, Box of Texas, Hudspeth of Texas, Whitehead of Virginia, Moore of Virginia.

[16] The succeeding paragraphs are based upon tabulations of data from the files of the *Congressional Record*, 71st Congress, 3rd Session.

[17] In the case of Senator Simmons due allowance should be made for his ill health.

953 entries of "present." The average number of absences per individual was 6; seven lame-duck Representatives were present at every one of these roll calls;[18] eight had 15 or more absences recorded against them.[19]

Sixty-two times the roll of the Senate was called upon a demand for "yeas" and "nays." Here we find the twelve Senators for whom this was the last session running up a total of 328 entries of not voting, as opposed to 416 entries of yea and nay votes. The average per individual was 27 abstentions;[20] however, Goff of West Virginia and Phipps of Colorado are conspicuous, with but 5 and 8 abstentions, respectively, but Simmons and Steck are again on the other extreme with 46 and 50 for their record.

Thirty-three yea-and-nay roll calls were taken in the House of Representatives. The seventy-four lame ducks accumulated 786 entries of "not voting" out of a grand total of 2,445 entries; there was a total of 1,659 yeas and nays. The average number of abstentions was approximately 10; yet we find that a dozen of these defeated and retiring members withheld their vote but once or twice,[21] but five voted only twice or thrice during the entire session;[22] indeed, Hudspeth of Texas did not vote at all on a yea and nay vote, and Doyle of Illinois cast only one ballot on such a vote.

The lame-duck Senators introduced seventy-two bills and twenty-two resolutions during the session; the retiring Representatives proposed seven hundred and twenty-three bills and about seven resolutions. The vast majority of these measures died in committee; some were reported back to the house in

[18] These were Box of Texas, Chalmers of Ohio, Cramton of Michigan, Fisher of Tennessee, Morgan of Ohio, Oldfield of Arkansas, Wolverton of West Virginia.

[19] Dempsey of New York, Doyle of Illinois, Hoffman of New Jersey, Hudspeth of Texas, Kunz of Illinois, Michaelson of Illinois, Rowbottom of Indiana, Thompson of Ohio.

[20] The practice of "pairing" accounts for a number of abstentions.

[21] Chalmers of Ohio, Cramton of Michigan, Hall of Indiana, Hull of Wisconsin, Johnson of Nebraska, Jonas of North Carolina, Letts of Iowa, Miller of Washington, Oldfield of Arkansas, Ramey of Illinois, Sloan of Nebraska, Wolverton of West Virginia.

[22] Bell of Georgia, Hoffman of New Jersey, Michaelson of Illinois, Rowbottom of Indiana, Thompson of Ohio.

which they originated and got no farther; very few passed both houses of Congress and secured the approval of the president. The chief measures sponsored by lame ducks in the Senate and enacted into law had to do with the construction of interstate bridges. In the House of Representatives two measures of first importance were introduced by them.[23] These were the Department of Interior Appropriation Bill, introduced by Cramton of Michigan,[24] and the emergency and regular public-building construction acts officially presented by Elliott of Indiana.[25]

When it comes to the matter of determining how much effect these eighty-six men and women may have had upon the legislative result of the session, we should consider their activity on the floor of the House and Senate and their participation in debate in their respective chambers.

Several of the lame-duck Senators were notorious for their loquacity and for their desire to speak for Buncombe, yet it remains a fact that at no time in this particular short session did a lame duck indulge in a gross attempt at filibustering. Heflin did devote much of his oratorical efforts to a depiction of the maladies of Alabama politics and, as he saw it, the theft of his seat in the Senate.[26] Both Gillett and Heflin gave some meat to the debates upon unemployment and drought relief,[27] while Goff did yeoman service in defense of the administration when the recall of the hastily confirmed members of the Federal Power Commission was before the Senate.[28] For the rest, silence was golden, although Blease did enliven matters with a testy protest of his treatment at the King's Mountain celebrations.[29] But

[23] Both measures were more properly government bills, deriving their importance from that fact.

[24] Cramton ranked second on the Appropriations Committee on the majority side.

[25] Elliott was chairman of the House Public Buildings and Grounds Committee.

[26] *Congressional Record*, 71st Congress, 3rd Session, pp. 2275–2277, 2794–2802, 3525–3531, 3551–3553, 5610–5617, 5941–5942, 6707–6714.

[27] Heflin, *ibid.*, pp. 310, 359, 371, 2096–2099, 2168, 2267–2271, 2482–2484, 2602–2603; Gillett, *ibid.*, pp. 1231–1235, 2180–2181, 2480–2482.

[28] *Congressional Record*, 71st Congress, 3rd Session, pp. 1545–1563.

[29] *Ibid.*, pp. 83, 482.

when noon was struck on March 4, 1931, the floor was held by no lame duck bent upon stemming the tide of essential legislation; the stroke of twelve found Thomas of Oklahoma lingering upon the miseries of the petroleum industry.

Naturally, less opportunity for extended speeches exists in the House of Representatives. Consequently, long speeches are few and far between, if indeed they occur at all. Under these conditions Cramton of Michigan spoke from the floor no less than two hundred and twenty-seven times in the course of the session; Irwin of Illinois addressed the House at least sixty-three times; Fort of New Jersey did so thirty-three times, making a significant speech in favor of the Gifford resolution to abolish lame-duck congresses.[30] Other loquacious members of the lame-duck contingent in the House were Moore of Virginia, O'Connor of Oklahoma, Sloan of Nebraska, and Sproul of Illinois.

Still others were roused to activity over a single measure or topic. Thus Senator Phipps of Colorado, the chairman of the Senate Post Office and Post Roads Committee, retained for himself the rights of his office in making reports and in steering legislation which related to that subject. We have noted the activity of Cramton and Elliott in regard to the Department of Interior Appropriation Bill and the public-construction acts. Denison of Illinois was noted for his support of legislation affecting the Canal Zone, since the majority of his forty proposed bills related to that subject; Fitzgerald of Ohio and Irwin of Illinois labored in behalf of the Claims Committee of the House; Zihlman of Maryland was prominent as the chairman of the House Committee on the District of Columbia; Brigham of Vermont was roused to action in defense of the proposal to increase the tax on oleomargarine. Nevertheless, thirty-two of the House lame ducks spoke no more than a single time.

Such is the record of the lame-duck members of Congress in the short session of 1930–31. Some were active; others were not, perhaps never had been; surely the odds are that any group of eighty-six would similarly react when forced to operate under the same set of circumstances and in the same environment. In

[30] *Ibid.*, pp. 5972–5973.

truth, the trouble lies not with the mere presence of defeated members or the character of their actions in Congress, but with the system of holding one of the two regular sessions of a Congress after an election has decreed the membership of the succeeding Congress.

Viewed in that light, the problem stems back to the old controversy as to the proper function of the delegated representatives of the people under any scheme of representative government. Should the representative reflect the wishes, desires, and caprices of his constituents, or should he lead them to the proper concept of public interest and to a better comprehension of what is the greatest good for the greatest number?

The answer is not obvious; it defies summarization in one set formula, pat for all occasions. It must be an individual reply and formula, and the opinion of each bears equal weight. We cannot forget that the devices of functional representation and their forerunner, the lobby, are forcing us to recast our theories of legislatures and legislation. Still it is clear in all these doctrines that responsibility to the constituency must somehow be enforced upon the delegated representatives.

In the United States we attempt to do so at the biennial election in November of the even-numbered years. The election occurs, however, between the two regular sessions for which the member of Congress is empowered to serve. To those returned to Congress success at this election gives a comparatively light heart, so far as their political fate may be involved in the outcome of the short session. The memory of the average voter is reputedly short, and a victorious Congressman has two years of relative peace before the wrath of the voters can be felt in a way that carries a sting.

Theoretically, those defeated at the polls have forfeited the confidence of their constituency, yet by a queer quirk of fate they still hold in their hands the mandate to serve in the sessions for which they were elected. Repudiated, they are still fulfilling the responsibility placed upon them two years before. They possess, and at the same time they do not have, the confidence of the electorate. It is small wonder, then, that the defeated mem-

ber, facing such a paradoxical situation, either seeks to wreak his will in the short session, enjoy one more fling before the wine of his political cup is drained, or, in his bitterness, folds up completely. Since he is still in Congress, he is a convenient scapegoat, not only for the country at large, but for other members of Congress who for several years will not fear the same fate, and hence may not scruple to pass to him the burden of the short session and its consequences.

This does not mean that the lame duck is unspotted, Simon-pure, guiltless of any or all of the evils charged to him. There have been times when "lame-duckery" went rampant and ran amuck, wrecking the entire session, leaving it bereft of any socially desirable results. Only a long study of session after session would show whether or not there is a lame-duck state of mind which envelops each and every defeated or retiring member and causes him to deviate from the normal course of action when faced with apparent political death. And, on the other hand, if inaction and listlessness and a greater degree of pettiness mark the conduct of lame ducks, does that not point a moral to the effect that their removal would deprive our congressional meetings of no essential spiritual element?

But how may we achieve this purification of our national Congress? A difficult and complicated way is that of constitutional amendment. At last a concrete proposal has been submitted for the consideration of the units which make up the process of amendment. As it comes from the conference committee of the House and the Senate, it proposes to accomplish the goal sought in this fashion.

Section 1. The terms of the President and Vice-President shall end at noon on the twentieth day of January, and the term of senators and representatives at noon on the third day of January of the years in which such terms would have ended if this article had not been ratified; and the terms of their successors shall then begin.

Section 2. The Congress shall assemble at least once in every year, and such meetings shall begin at noon on the third day of January, unless they shall by law appoint a different day.

Section 3. If at the time fixed for the beginning of the term of the President, the President-elect shall have died, the Vice-President-elect shall become

President. If a President shall not have been chosen before the time fixed for the beginning of his term, or if the President-elect shall have failed to qualify, then the Vice-President-elect shall act as President until a President shall have qualified; and the Congress may by law provide for the case wherein neither a President-elect nor a Vice-President-elect shall have qualified, declaring who shall then act as President, or the manner in which one who is to act shall be selected, and such person shall act accordingly until a President or Vice-President shall have qualified.

Section 4. The Congress may by law provide for the case of death of any of the persons from whom the House of Representatives may choose a President whenever the right of choice shall have devolved upon them, and for the case of death of any of the persons from whom the Senate may choose a Vice-President whenever the right of choice shall have devolved upon them.

It is readily apparent that the necessity for the use of our cumbersome amending process arises because it is proposed that the date for the commencement of the presidential, vice-presidential, and congressional terms be changed from March to January. The proposed amendment, popularly called the "Norris Amendment," offers hope for the substantial solution of other troublesome problems of American government in addition to the abolition of the lame-duck Congress. If within the period of seven years following the submission of the amendment for ratification such ratification takes place, then we should have no more lame-duck congresses. If the amendment fails, then we are no further along, despite all the effort.

Legislatures in three fourths of the states must accept the amendment before it can be proclaimed part of the Constitution. How difficult that is can be inferred from the fate of five of the twenty-four amendments that have been proposed by Congress; only nineteen gained the necessary quota for ratification, and ten of those came quite early in our history. Recent experience seems to indicate that any amendment now proposed will have difficulty in overcoming the prejudices aroused by the presence of the Eighteenth Amendment in the Federal Constitution. We can only await the lapse of time.

But even though the proposed amendment never does secure the number of approvals requisite for the ratification, does that mean that we must forever put up with lame-duck congresses?

By no means. Another method by which this cleansing of our Congress can be attained is that of statutory enactment. Congress has authority under the Constitution to fix by law another meeting date. Indeed, such changes have been proposed on several occasions and have been accorded serious consideration, as Professor E. S. Brown has shown.[31]

The new Congress might still have to commence its term on March 4, if the constitutional date is left unchanged by the failure of the amendment now proposed. A plausible scheme might provide that the new Congress convene on that day, March 4, and serve its annual session quite early in its life as a legislative body, without ageing until December. There need be no limit to the length of this early session. Assuming that such a session would last at least three months, there would follow a recess during which the members remain subject to call for a special session. The second of the two annual sessions of the Congress meeting under this scheme might well convene in January of the even-numbered years and thus eliminate the break caused by the December holidays. This session might be permitted the luxury of sitting as long as it cared to do so. Hot weather in midsummer, the coming elections, the constitutional power of the president to adjourn Congress in case of disagreement between the two houses concerning the date of adjournment, all would act as controls upon the length of this session. Every fourth year a formal session would have to be provided in order that Congress might canvass the votes of the electoral college.

One must concede that the statutory enactment, considered here a last resort in the event that the lame-duck Congress cannot be abolished by the method of constitutional amendment, has much to commend it as a means of dealing with this problem. It is a swifter substitute for the cumbersome process of constitutional amendment; it is flexible, permitting future change should the original scheme prove unsatisfactory. It obviates the necessity of an appeal to forty-eight state legislatures which have scant

[31] Brown, E. S., "The Time of the Meetings of Congress," *Am. Pol. Sci. Rev.*, 25 (1931): 955–961.

interest in the result of that appeal; and it centralizes in Congress itself, the body most vitally concerned, the responsibility for removing any stigma that may attach to the short session by reason of the presence of the lame duck.

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SOME PHONOLOGICAL, ORTHOGRAPHICAL, AND SYNTACTICAL ASPECTS OF THE PERSISTENCE OF THE FRENCH PRESENT SUBJUNCTIVE ENDINGS *-ONS* AND *-EZ*

NEWTON S. BEMENT

THERE is no case in which the French present subjunctive ending *-ions* would have been produced by the regular operation of phonetic laws. Instead, these laws produce the following terminations:

-ir verbs: *-iens* from *-iamus;*
-oir verbs: *-iens* from *-eamus;*
-re verbs: *-iens* from *-amus* preceded by a palatal;
-er verbs: *-eins* from *-emus;*
-er verbs: *-ins* from *-emus* preceded by a palatal;
-re verbs: *-ains* from *-amus.*

The ending *-ions,* therefore, is commonly explained as a compromise resulting from the combination of the ending *-iens,* which was employed in eastern France and Picardy, with the ending *-ons* deriving from *sons* (*soms, somus,* of the verb *estre, essere, esse*), which, owing to analogical influence, was employed from the beginning of the literary period.

The present subjunctive ending *-iez* would have been regularly produced in the cases of:

-ir verbs, from *-iatis;*
-oir verbs, from *-eatis;*
-re verbs, from *-atis* preceded by a palatal.

Other endings likewise would have been regularly produced:

-re verbs: *-ez* from *-atis;*
-er verbs: *-eiz* from *-etis;*
-er verbs: *-iz* from *-etis* preceded by a palatal.

However, *-iez* was not regularly employed until after 1500. Instead, owing to the analogical influence of *-er* verbs, it was supplanted in many cases by *-ez* or *-oiz* (e.g. *tenez, viegnoiz, sachez, sachoiz*). This ending of the *-er* verbs, that is, *-eiz* (or *-oiz*, the distinction being merely orthographical), became generalized in their case, in a portion of eastern France. But in most of the dialects, including Francien, it was replaced early, either by *-ez* (not from the subjunctive ending *-etis*, but from the corresponding indicative ending *-atis*), or by *-iez* (from *-atis* preceded by a palatal). Thus Latin indicative *tractatis* would produce French indicative and subjunctive *traitiez*, with which we may compare:

Je veux que la traictez bien, et ne faites pas le fantastique (Desp., 125).[1]

Let us turn now from the modern philologists to the grammarians of the period. "Ie n'ay point veu de Grammaire," says Antoine Oudin, writing in 1640,[2] "où ie n'aye rencontré quelque defaut touchant l'arrengement des verbes:[3] en l'une i'ay trouvé des anomaux placez au lieu des reguliers,[4] en l'autre des terminaisons confonduës" (144). Oudin anticipates us. Most of the grammarians, however, distinguish the subjunctive endings orthographically from the indicative endings, in the first and second persons plural of the present tense, by employing *-ions* and *-iez*, generally conjugating *aimer*, for example: Palsgrave (*parler*), Dubois or Sylvius (*-iēs*), Robert Estienne, Meigret, Garnier, Ramus or La Ramée (1572: *-ies*), Madio, Maupas. Du Guez employs *-ons* and *-ez*, although he uses *-ions* and *-iez* in the imperfect indicative, imperfect subjunctive, and present conditional, thus indicating an absence of analogical influence, at least in orthography. We may imagine that Du Guez was merely indifferent to an orthographical distinction. He specifies *l mouillé* in the pronunciation of his subjunctive forms *engenoullons*,

[1] A bibliography is appended, and also a list of abbreviations.

[2] *Grammaire françoise rapportée au langage du temps*, deuxième édition (A. de Sommaville, Paris).

[3] Oudin distinguishes four conjugations: *aimer, finir, devoir, rendre.*

[4] The majority give irregular verbs as examples. Some very ingenious distinctions between conjugations are provided.

–éz, and in the imperfect gives *engenoullions, –iez*. Palsgrave, on the other hand, indicates that the yod may or may not be written, as we shall note.

Regarding other classes of verbs, we find in one of the earliest grammars [5] an indifference extending in both directions:

Pres. indic.: *punions, dormions, dormez;*
Pres. subj.: *tiegnons, viegnions, aillons, veullions, veulliez, lisions, bevons.*

At the other chronological extreme of this period of indifference we find *lisons* and *lisez* given as the subjunctive by Robert Estienne in 1540, although he indicates the yod in verbs where no intervocalic *s* is involved (*dormions, recevions*). Between these extremes Palsgrave and Du Guez provide some instructive examples.

Du Guez gives as the present indicative, *veons*, imperfect, *véions*, and seems possibly to indicate the yod by spelling the present subjunctive *voions*. That is, *voions* may indicate a pronunciation as of *véyons*, corresponding to his indicative *veons*, since, after the latter part of the thirteenth century, the phonetic value of *oi* was frequently that of *è* in *père* today.[6]

Palsgrave,[7] by giving for the indicative the forms *devóns, devéz*, and for the subjunctive the forms *doyións, doyiéz*, seems to make the yod the outstanding distinction between the two moods, if we keep in mind the phonetic value of *oi* or *oy* (*dèyons, dèyez*). However, other examples from his work make it apparent that the insertion of *i* was not entirely necessary:

Pres. indic.: *fuyóns, fuyéz;*
Pres. subj.: *fuyións*, but *fuÿéz.*

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[5] *Donait francois pour briefment entroduyr les Anglois en la droit language du Paris et de pais la d'entour fait aus despenses de Johan Barton par pluseurs bons clerc du language avandite.* Dated 1400 or before 1409, according to Stengel.

[6] Henri Estienne states that in his time one no longer dared to say *François*, but must say *Frances* (*Langage françois italianisé*, Genève [1578], p. 22). The same movement is indicated in Geoffroy Tory's *Champfleury* (Paris, 1529), folio XXXIII, v°.

[7] We may assume that Palsgrave's usage reflects Parisian usage in 1514, when he entered the university as a Cambridge graduate. Even his rival, Du Guez, admits that he is "elegant" in French. He does not hesitate to correct the examples which he draws from authors of the preceding period.

Still another case shows that the insertion of *i* was orthographically, but not phonetically, an accident, when, with reference to the present subjunctive of *dire*, Palsgrave happens to write:

que je die, . . . dies, . . . die, . . . dións, . . . diéz, . . . dient, puttynge no consonant before *ions* and *iez*, except the fyrst parson singular have one, as *que je préigne, . . . préignes, . . . préigne, . . . preignóns, . . . preignéz, . . . préignent* (96).

Here, orthographically, the *i* is conspicuously absent, as it is in his subjunctive *vueillons*, although it reappears in his imperative *vueillions*. In other words, the yod was still indifferently represented by Palsgrave in 1530, and to some extent by Robert Estienne in 1540.

In summary, three periods may be discerned in the works of the grammarians. In the first, represented by Barton's work at the opening of the fifteenth century, *i* is either written or omitted, indifferently, in both moods. In the second, which ends about the year 1540, *i* is either written or omitted, somewhat indifferently, in the subjunctive, and does not appear in the indicative. In the third, that is, after 1540, *i* is no longer omitted in the subjunctive.

Be it said, to the credit of the grammarians, that the indifference which we have noted in Palsgrave was longer-lived in the case of the writers. We find it still at the close of the sixteenth century and the opening of the seventeenth. Du Vair provides these examples:

Laissez croistre l'un et l'autre jusques à la moisson . . .: de peur que, voulant cueillir l'Ivroye, vous n'*emportez* le bon bled quant et quant (157); Quelle pitié, que nous ayons veu ces jours passez seize coquins de la ville de Paris faire vente au Roy d'Espagne de la couronne de France . . . ! et que nous *voyons* maintenant une autre espece de gens . . . conjurer et travailler jour et nuit pour renverser les fondemens de l'Estat . . . ! (123).

The correction *emportiez* appears in the editions of 1606, 1625, and 1641, but *voyons* remains, and the reason why it was overlooked seems sufficiently obvious. Malherbe corrects the omission of *i* in the imperfect indicative of the same verb, when he finds it in Des Portes:

D: Si vous *voyez* mon cœur ainsi que mon visage.

M: *Voyiez.* (Malh., IV, 367)

Yet in his letters Malherbe himself displays a probably inadvertent indifference:

(je) desire que vous en *oyez* bientôt (III, 97); il me suffit que vous *voyiez* que je suis votre serviteur (III, 225); Il me suffit que vous *voyez* que ce n'est pas la paresse qui m'empêche de vous faire une plus longue lettre (III, 383).

In earlier works examples of indifference are less rare, e.g.:

Pres. indic.: *deviez* (Fail, Eutr., 215, 216); *deviez* (var. P., *debvriez*) (Comm., II, 174);

Pres. subj.: *battons* (Mont., III, 365); *aymons* (Calv., R. C., 767); *sachez* (Rab., G., 46–46); *regardez* (Marg., I, 12);

Impera.: *abreviez* (abbreviare) (Rab., P., 11–110): cf. *bailliez* indic. (bajulare) (*idem*, P., 10–68); *vous l'aymiez & serviez* (optative) (Marg., I, 59).

These few examples indicate some of the problems involved in a study of the persistence of the subjunctive endings *–ons* and *–ez*. A detailed examination of texts, at least within certain limits, becomes necessary. For this purpose we have chosen Joinville, born in Haute-Marne, Marguerite d'Angoulême, and Calvin, whose *Institution* appeared one year after Robert Estienne's subjunctive *lisons* and *lisez*.

The following table of forms, drawn from Joinville's work, shows the great potential analogical influence of other verbal endings on those of the first and second persons plural of the present subjunctive:

	Imp. indic.	*Cond.*	*Imp. subj.*	*Pres. subj.*	*Impera.*
amer	amiens [8] (amions)	ameriés	amissiez		
donner		donriens donriés		donnés donnez	donnés
demourer	demouriés		demourissiens (demourissons)		
garder	gardiens (gardions)	garderiens (garderions)		gardons gardez	
cuidier	cuidiens (cuidions) cuidiés				cuidiés (cuidés)
mangier	mangiens (mangions)	mangeriens (mangerions)		mangiens	

[8] Forms in parentheses are not common to all manuscripts. They are rejected by the editor.

	Imp. indic.	*Cond.*	*Imp. subj.*	*Pres. subj.*	*Impera.*
envoier		envoieriens (envoierions)	envoissiens (envoison)	envoions	
atandre	atendiens (attendions)	atenderiens (attenderions)	atendissiens (attendission)	atendés (attendés)	
occirre	occions			occions (occion)	
devoir	deviens (devions)	deveriez (devriez)			
avoir	aviens (avions)	averiens (ariens) (arions) averiés (auriés)	eussiens (eussions) eussiez	aiens (aions) aiés	ayés
estre	estiens		fussiens	soiés	soiés
aler	aliés	iriens (irions) iriez	alissiens (allisons) (alissions)	alons alez	alons alez alés
faire		feriens feriés	feissiens (feissions) feissiés	façons facez faciez faites	façons fesons faites
mettre				metiens metons (mections) metez metiez	metons
pooir	poviens (povions)	pourriens (pourrions)	peussiez	puissiens puissons (puissions) puissés puissiez	
savoir		sauriens (saurions)		sachiez	sachiez (sachez)
venir	veniens (venion)	venriens (vendrions)	venissiens	veignez	venez venés
veoir	voiens			voiens (voions) veéz voyez	
voloir vouloir	voliens vouliens (voulions)	vorriens vourriés	vousissiens (vousissons)	vueillons vueillez	

A comparative examination of these forms reveals, as modern philologists have implied, the highly probable existence of the yod in the endings *–ons* and *–ez* in the spoken language long before it appears in orthography. However, it reveals also the closer relationship between the subjunctive and the imperative than between the subjunctive and any other forms.

In Joinville's work there are forty-two unquestionable occurrences of *–ons* and *–ez* or *–és* (and including also *–tes*) as present subjunctive endings, twenty-eight of which occur in clauses dependent on volitional expressions (e.g. *prier*, *commander*). These occurrences involve the following forms:

gardons (132), lessons (112), prenons (93), tenons (287), metons (72), prions (72), vueillons (207), façons (123);

gardez (203, 248), pensez (149), acoustumez (10), donnez (86), commandez (23, 241), atirez (220), tournez (230), copez (141), veignez (155, perhaps veigniez as 384), tenez (117), retenez (59), metez (224), priez (187), vueillez (59), véez (211), voyez (243), alez (150, 220), ralez (162);

donnés (33), chaciés (160), metés (10), atendés (230), deffendés (235), preignés (135), puissés (150, 220);

faites (8, 29), dites (162, 178, 244).

Each of these forms, excepting *veignez* amd *preignés*, is identical with an imperative form. We find also imperatives, or optatives, ending in *–iez* and *iés: vous taisiés* (11), *taisiés-vous* (21), *sachiez* (163, 283). The Latin plural imperative (e.g. *cantate: chantet*), in fact, was not adopted in Old French; and although the singular was adopted (*canta: chante; vade: va*), the subjunctive was employed instead in some verbs (e.g. *aies*, *seies*, *saches*), from the beginning of the literary period. The opinion has long since been expressed that the plural imperative forms were "borrowed from the indicative, or perhaps from the old form of the subjunctive" (Brun., 1894, p. 420). The reader will immediately evoke some modern plural forms. In Joinville's work we find a sixteenth-century copyist replacing an old imperative with a new one:

Et vous commant . . . que se les X. mile livres ne sont païes, que vous les *facez* paier (14th-cent. copyist);

Je vous commande . . . que si les dix mille livres ne sont payées, que vous les *faictes* payer sans nulle faulte (16th-cent. copyist); (xxxii).

Or perhaps we should call it an optative or a subjunctive form, if there were a generalized distinction between these three forms in Joinville's work. In the singular, however, the imperative is more readily distinguishable from the subjunctive, so that the following example offers greater evidence of the passing of the paratactic form into hypotaxis:

je te pri que il te preingne pitié de moy, et m'*oste* de ces guerres entre crestiens; et m'*otroie* que je puisse mourir en ton servise (99).

The editor corrects these forms, making them subjunctives (*ostes, otroies*) and basing his correction on *otroies* in the passage quoted in note 11. For the present we merely call attention to the expression of entreaty on which they depend, and pass on to the fact that the subjunctive and imperative forms frequently occur together in constructions in which it is difficult to distinguish any dissimilarity between them as moods:

Et vous commandons que vous en *ralez* . . ., et dedens quinzainne vous *soiés* ci-arière, et *apportez* au roy tiex lettres . . . dont li roys se tieingne apaiez et que il vous en sache bon grei (162).[9]

The change from paratactic to hypotactic construction is constantly and freely made:

Sire, il me semble que il iert bon *que vous retenez* . . .; et *face l'on crier* . . . que . . . (159); et (je) vous comant *que vous tournez* vos voiles, et *lour alons courre sus* (230).

Likewise, the manner of combining the third-person forms (later distinguished as optatives) with that of the first person (later an imperative) leaves no distinction between them:

(dont Diex nous *gart* par sa grace, et nous meismes nous en *gardons*! . . .) (286).

For the moment we leave Joinville, after quoting more fully to show his orthographical variability:

[9] Arbitrarily: *ralez* subjunctive, *vous soiés* optative, *apportez* imperative. We also find *que* repeated: je vous pri, sire, *que* cest enfant que vous avez avec vous, *que* vous le tenez touzjours par le poing (117); Je vous demant, . . . *que* se . . ., *que* vous me copez la teste (141). We shall later consider the matter of "optative *que*."

ne vous loons-nous pas que vous *metez* . . . (224); raimbez-nous de quant que nous avons, mais que vous ne nous *metiez* là où on met les murtriers (230); pour ce que (afin que) vous *véez* . . . (211); pour ce que vous *voyez* . . . (243); Liquiex Diex nous gart et nous otroit que nous le *puissons* veoir face à face (288); Diex te doint grace de faire sa volenté touzjours, si que . . . tu et nous *puissiens* . . . estre ensemble avec li (var., puissions) (266); . . . gens et deniers, par quoy vous *puissés* . . . (150); Pour ce que vous *puissiez* veoir que . . . (268); Donques vous gardez que vous ne *faites* ne ne *dites* . . . (8); Et vous commant . . . que vous les *facez* paier (137); Dont nous vous loons devers nous que vous *faciez* ce que . . . (224).

There exists also another sort of variability. Between the time of Joinville and the sixteenth century some verbs change conjugations. Some drop *i* from the stem (e.g. *lessons* subj., *lessiés* indic., 112), but, on the other hand, a yod might distinguish the subjunctive at one period (e.g. *oez* indic., 16), and yet become later an indicative or an imperative (*oyez*). In the sixteenth century this sort of variability is considerably decreased, but the question still involves phonology, orthography, and syntax.

In the *Heptaméron* there are twenty-seven occurrences of the subjunctive endings *–ons* and *–ez* (including also *–tes*). They involve the following forms, after some of which we place other forms for comparison:

prenons (II, 250);

oblyons (II, 12): obliant (II, 150), oblyé (II, 208), oublient (II, 142: indic.);

voyons (I, 48);

veullons (III, 83);

ostez (II, 127);

gardez (I, 217): gardez (II, 130: impera.);

regardez (I, 12): regardez (I, 32: impera.);

touchez (III, 69): cachez (I, 226: impera.), sçachez (I, 119: impera.), sçachons (II, 88: impera.), sçachions (III, 92: subj.);

pleurez (II, 206);

promettez (II, 80): vous promettez (III, 139: impera. or opt.), promettiez (I, 63: subj.), mectez (III, 193: impera.), mectiez (II, 247: subj.);

prenez (I, 230; III, 142): prenez (II, 16: impera.), prenne (III, 42: subj.), aprenne (II, 227: indic.), suffise (III, 113: indic.);

oyez (II, 206; III, 39);

croyez (III, 193: ie suis contente que vous le croyez; not necessarily subj.): croyez (I, 65: impera.);

soyez (II, 141: counted once only);

craignez (II, 129): craignez (I, 71: indic.), craigniez (I, 75: subj.), daigniez (II, 56: subj.), esloingniez (I, 58: subj.), craignions (I, 94: subj.);

vueillez (I, 138);

veillez (vouloir) (III, 114);

veullez (I, 96; III, 121): veulliez (III, 83: subj.), veullent (II, 16, 156), il veulle (II, 111: subj.), veulle (III, 153: impera.);

voulez (III, 135): voulez (I, 12; III, 114: indic.), voullez (II, 222: indic.), vouliez (I, 112: subj.);

dictes (I, 230; II, 20; III, 12, 21, 138): dictes (I, 32; II, 86: indic.), dictes (I, 63, 91, 104; II, 178, 260: impera.), je dy (II, 108: indic.), je dye (II, 110; III, 190: subj.), dient (II, 78, 210: indic.), disent (II, 156: indic.), disons (III, 29: indic.), faisons (III, 62: indic.), faictes (II, 43, 200: impera.), fassiez (III, 200: subj.).

The *Heptaméron* is edited "d'après les meilleurs manuscrits, respectant l'orthographe, bien qu'elle ne soit pas toujours uniforme" (I, 258), and so, since there are twelve manuscripts in the Bibliothèque Nationale, our collection of forms is a composite one. The work is also much longer than Joinville's *Histoire de Saint Louis* combined with his *Credo* and his *Lettre à Louis X*. Despite these facts it offers a considerably smaller number of forms that resist phonetic explanation. In half of the forms a yod is supplied in the stem. The endings of these forms may exert some analogical influence on the orthography of the endings of other forms, but this influence is counterbalanced by the presence of still other forms with endings in which *i* is written. In the other half of the forms the yod might be assumed to be present in the pronunciation of *prenons* and *prenez*, in view of Joinville's and Palsgrave's orthography, and in that of *voulez*, in view of the variants. It might also be present in the pronunciation of *touchez*. For the remaining cases we may resort to a syntactical explanation which might well apply to all cases.

This syntactical explanation involves demonstrating a lack of distinction between paratactic and hypotactic forms, or independent and dependent construction. We may begin with direct and indirect quotations. Three of the inconsistencies which exist in the texts are:

(1) An indirect quotation following a verb better suited to introduce a direct quotation: Et il me *dist* comment je le savoie; et je li diz que je en cuidoie estre certeins (Joinville, 16);

(2) An indirect quotation inappropriately retaining the tense, and occasionally a pronoun, from the direct quotation: Et li loa que sitost comme il venroit en Acre, que il li en *souvieingne* (Joinville, 143); Et aussy elle leur dist (dixit) que l'un après l'autre *veuille* prendre son plaisir de *moy* (Marg., I, 63);

(3) A direct quotation introduced by the conjunction *que*, or the passing of the forms of the direct quotation into the dependent clause of the indirect quotation, as in Marg., I, 63, above: lors redist li viex hons que "donc ne vous devez vous mie plaindre. . . ." Et après nous dist que " se votre Diex avoit eu pooir de. . . ." (Joinville, 280); le gentil homme . . . ne sceut que dire à son compere sinon que le mauvais garson que nous cuydions tromper le nous a bien randu (Marg., III, 60).

Continuing this démonstration we quote from the *Heptaméron* four sets of examples illustrating the passing of the new imperative (or old subjunctive) (first set) into dependent construction (fourth set):

(1) ie vous prie recepvez mon conseil (I, 12); Ie vous supplie, mes dames, regardez quel mal . . . (I, 32); Ie vous prie, mes dames, pensez si . . . (I, 65); Ie vous prie, dictes moy . . . (I, 91); Mon amy, ie vous prie, resiouyssez vous (I, 93); Ie vous prie, dist Amadour, dictes moy . . . (I, 104); ie vous prie, cachez vous (I, 226); Ie vous prie, dist Ennasuitte, prenez ma place & nous racomptez . . . (II, 16); ie vous supplie, si vous n'avez volunté d'aymer parfaictement, ne vous pensez poinct dissimuler (II, 19); Or ie vous prie, dist Saffredent, laissons ceste dispute (II, 134); Ie vous prie, dist Nomerfide, laissons là . . . (II, 147); Ie vous prye, dist Ennasuite, dictes moy . . . (II, 178); Ie vous prie, dictes . . . (II, 260); Ie vous prie, ma dame, dist Dagoucin, prenez ma place & le nous dictes (III, 149); ie vous supplye, mectez le à serment (III, 193);

(2) ie vous prie compter . . .; & gardez vous de . . . (II, 130);

(3) vous priant que incontinant que vous serez party d'avecq moy vous en alliez à travers le chemin, & vous gardez que ceulx qui sont icy ne vous voient (I, 217); vous priant que si vous voulez que ie continue l'affection que ie vous porte, ostez non seullement la volunté mais . . . (II, 127); ie vous commande que vous ne pleurez poinct & oyez ce que ie feray (II, 206);

(4) Ie vous supplie, ma dame, dist Geburon, s'il est ainsi que vous prenez ma place & que vous le dictes (I, 230); vous priant que vous & moy oblyons . . . (II, 12); vous suppliant, Monseigneur, que doresnavant vous ne craignez vous adresser aux . . . (II, 129); Ie vous prye, dist Simontault, que vous nous le dictes (III, 12); ie vous requiers que si vous en avez le moindre sentiment de soupson qui puisse estre, que vous le me dictes (III, 21); Ie vous supplie, mes dames, que voulez garder que l'on ne touche poinct à mon honneur (III,

135); ie vous supplie, si vous sçavez quelqu'une autant à l'honneur de quelque dame, que vous la nous veullez dire (I, 96); Ie vous prie, dist Longarine, que vous prenez ma place (III, 142).

From a comparison of these examples it appears probable that the retention of the imperative forms, which occurs especially after verbs of entreaty, created an analogy which delayed the general introduction of *i* in the first and second plural endings of the present subjunctive, although *i* does occur after the same expressions in the *Heptaméron:*

Ie vous supplie, dist il, que vous me donniez . . . (I, 92); Ie vous prie que à son exemple nous domorions victorieuses de nous mesmes (III, 263); or ie vous prie, dist Parlamente, que vous nous la comptiez (II, 266); ie vous prie . . . que vous nous le veulliez dire (III, 83).

The employment in dependent construction of the same forms that occur in independent construction implies that a complete and invariable set of hypotactic forms, including those of the first and second persons plural, has not yet been adopted. Consequently, we might expect not only the imperative in place of the subjunctive, but also the reverse, which we may call an optative or a paratactic subjunctive:

Et Dieu vous *doint* grace, ma dame, de continuer l'honnesteté qu'il a mise en vostre cueur; & congnoissant que tout bien vient de luy, *vous* l'*aymiez* & *serviez* mieulx que vous n'avez accoustumé (I, 58).

Compare the imperative form in similar circumstances: Madame, ie voys faire ung beau compte, mais *vous* me *promectez* que vous n'en parlerez poinct (III, 139).

Compare the subjunctive, with but little, if any, difference in force: ie vous donne congé d'y coucher sans en avoir scrupule, mais que (pourvu que) vous me *promettez* deux choses (II, 80).

As our examples have shown, there is little distinction in usage between the old optative and the two forms which issue from it: the imperative and the subjunctive, the latter of which terms dates from the sixteenth century. In the new conjugation there will be a distinction of a general class of dependent verb forms having *que* before them. In the *Heptaméron* this distinctive *que* is not yet generally employed. Our contention that imperative or paratactic forms are carried over into hypotaxis is borne out by

the fact that they disappear from hypotaxis in proportion as this distinctive or "optative" *que* becomes established, that is, contemporaneously with the recognition of a set of hypotactic or dependent forms.

Up to this time we find *que* before the optative generally only in indirect quotations:

Et je li dis *que* par male avanture en peust-il parler (Joinville, 167: cf. Ce soit par male avanture, 232); La fille . . . luy dist *que* Dieu fust loué du tout (Marg., I, 122: i.e. lui dit: "Dieu soit loué!").

True optative *que* is rare (e.g. Chr., 3996). Ritchie [10] notes a rare and epic usage at the beginnings of the *chansons de geste* of the twelfth century (e.g. Oiez, seignor, *que* Deus vos seit aidanz!). He is of the opinion that this *que* is hardly distinguishable primarily from *que* employed with the force of *afin que* (cf. car, *que* on le sache, tant y sont avenu de grans fais . . . que . . ., Froiss., II, 2). In Commynes' *Mémoires* we have noted but a single example (I, 219). In Joinville's work [11] there are three examples, two of which may be entirely matters of punctuation. The third, if we compare the examples of direct and indirect quotations from his work, given above, may likewise be a matter of punctuation, besides occurring in a chapter which may have been taken from Geoffroy de Beaulieu. It is the only true example:

Et c'est grans honte au royaume de France, et au roy quant il le sueffre, que à peine puet l'on parler que on ne die: "*Que* dyables y ait part!" (247).

In contrast, there are forty-eight examples in which the optative is not preceded by *que*, e.g.:

(à cui Diex bone merci face!) (6); (dont Diex le gart!) (58); Si m'aïst Diex, sire, fis-je, oyl (154); y preingne garde li roys (15); vieingnent avant li clerc et li provère (45); Ainsi soies-tu maudis, comme . . . (89); ne vous desplaise (289); devant lou malade façons lire le romant qui devise et enseigne les poinz de nostre foi (288); pour Dieu alons à aus (190).

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[10] *Recherches sur la syntaxe de la conjonction « que » dans l'ancien Français* (Champion, Paris, 1907), p. 56.

[11] Et en la fin, très-douz fiz, *que* tu faces messes chanter pour m'ame et oroisons dire par tout ton royaume; et *que* tu m'otroies especial part et planière en touz les biens que tu feras. Biaus chiers fiz, je te doing toutes les benéissons que bons pères puet donner à fil (265).

In the *Heptaméron*, as we have implied, optative *que* is not yet established. There are twenty-nine cases in which it is absent and one in which it is present, e.g.:

Pleut à Dieu (I, 16); Dieu vous veulle amender (I, 70); Madame, prou vous face (II, 19); Or vienne doncques ce qu'il en adviendra (I, 179); A cela ne tienne (II, 138); A tous les diables soyez vous donné (II, 141); Ne vous deplaise, ma dame (III, 92); Ia à Dieu ne plaise (III, 98).

Que à tous les diables soyt la villaine qui . . . (III, 35).

After the *Heptaméron* the change is almost abrupt, except in poetry.[12] In the first two hundred pages of Des Perier's work *que* is omitted eighteen times and employed fourteen times. In Rabelais the proportion is higher on the side of omission. Then, in later authors, the pure optative without *que* begins to lose the imperative force which it possessed in the twelfth century, and becomes stereotyped, the subject being almost invariably *dieu* or *diable*. In Calvin's *Institution* optative *que* is omitted in forty-one examples and employed in one hundred and seventy-eight. Among them may be noted some modern subjunctive and imperative forms:

Voisent maintenant noz adversaires, et s'arrestent en ces masques exterieures (XXXIII); Le Seigneur Roy de Roys vueille establir ton Throsne en justice (XLII); quand nous verrons aucuns en povreté nous communiquions à leur indigence, et soulagions leur necessité par nostre abondance (160); Ayons (counted once only) donc cela devant les yeux (468); Nous aucontraire ayons souvenance, que . . . (669); Pourtant il nous soit certain, que . . . (575); Il leur soit en brief respondu, que . . . (566); la crainte de Dieu soit sur vous et regardez de faire comme il appartient . . . (758).

Que ceste raige soit loing de nous (60); Qu'il ne m'advienne point . . . que . . . (779); Que nous ayons donc cela pour certain, que . . . (176); Et que nous n'ayons point honte d'ignorer . . . (468); Et que nous soyons . . . (468); qu'ilz me respondent . . . (XXXIII).

In the *Institution*, a considerable work of some three hundred and fifty thousand or more words, there are forty-two occurrences of the subjunctive ending *-ons* and one of the subjunctive ending *-ez*. The disproportion is without significance, since Calvin

[12] In Ronsard, for example, *que* is omitted approximately twenty times as often as it is employed.

rarely employs the second person plural. These occurrences involve the forms below. Some comparisons are provided:

ayons (counted once only) (XXIX);

employons (154, 167);

croyons (265, 641);

voyons (269): voyons (756: impera.), voions (784: indic.);

veuillons (23, 32, 51, 56, 80, 90, 278, 374, 414, 612, 762): veuillions (47, 249, 469: subj.), aillieurs (523), allieurs (519), veuillent (449: subj.), veulent (314, 640: subj.), voulons (30: indic.);

travaillons (197): faillions (187: indic.);

complaignons (VII): craignions (196, 257, 514: subj.), assignions (484: subj.), conjoingnions (99: subj.);

testifions (601): testifie (614: indic.);

oublions (622);

glorifions (645): glorifions (816: indic.), se glorifiera (821);

prions (795);

magnifions (819);

jugeons (297); jugions (669: subj.), oultragions (781: subj.);

acquiesceons (145): acquiesceons (145: indic.), acquiescions (513: subj.), acquiescer (299), acquiessant (439), commenceons (146: indic.);

jouyssons (184);

obeyssons (731): obeissions (745: subj.);

congnoyssons (206);

congnoissons (822): congnoissions (802: subj.);

recongnoissons (214): recongnoissions (527, 819: subj.);

scachons (224);

cerchons (373): cerchions (383: subj.);

mesprisons (506): mesprisions (646: subj.);

rachetons (658): mettions (506: subj.);

descendons (4): rendions (795: subj.);

(viv)ons (590);

souffrons (708);

desirons (815): esperions (299: indic.);

tombons (644);

aymons (767): aymions (795: subj.);

offensez (742): reprenez (279: impera.), reputés (279: impera.).

Calvin's indirect quotations do not display the peculiarities which we have noted by example in the earlier works, nor does his work offer the same opportunities for showing the persistence of imperative forms in subjunctive clauses:

Je vous admonneste, gardez vous d'Antechrist (XXXI); Le commandement de Dieu est, que vous n'offensez point vos freres infirmes (742).

Voyons donc . . . (756); il n'est ja mestier que nous voyons . . . (269).

A glance at the list of forms above discloses that the majority may be grouped phonetically into a very few classes and that, orthographically, the forms having a yod in the stem (*y, i, ll, gn*) now constitute the main analogical influence deterring the universal employment of *i* in the subjunctive endings. The remaining cases appear to be traceable, in a degree at least, to erratic orthography. Both this and the influence of analogy are evident in examples:

l'ordre requiert, que nous *metions* celle de Dieu premierement: puis apres que nous *descendons* à l'autre (3); quand il enseigne (volitional) que nous *travaillons* pour nostre salut avec crainte et tremblement: il ne demande autre chose, sinon que nous *accoustumions* de . . . (197); tellement que (purpose) non seulement nous *estimions* Dieu tout puissant: mais que nous le *recongnoissons* comme celuy qui . . . (214); il n'est ja mestier que nous *voyons* une Eglise à l'œil, ou que la *touchions* à la main (269); le decret de Dieu ne nous empesche point, que nous *pourvoyons* à nous . . . et *mettions* ordre à noz affaires (506); Maintenant il appert, quel est nostre devoir. Si le Seigneur nous a baillé nostre vie en garde, que nous la *conservions:* . . . s'il nous offre les remedes, que nous ne les *mesprisons* point (506); A fin que par nostre confession nous le *glorifions:* et par nostre exemple, *exhortions* . . . (645); il dit (volitional) . . . que nous *gardions* la liberté . . . et que nous ne *souffrons* point d'estre assubjectis (708); Car ceste est sa volunté eternelle et immuable, qu'il soit honoré de nous tous: et que nous nous *aymons* mutuellement l'un l'autre (767); Il n'y a que ceste voye, par laquelle on puisse parvenir à ce qui est non seulement difficile à la nature humaine, mais du tout repugnant: à scavoir, que nous *aymions* ceux qui nous hayssent, que nous *rendions* le bien pour le mal, que nous *prions* pour ceux qui mesdisent de nous (795); tellement neantmoins que (purpose) nous *desirons* tousjours nostre mort, et la *medition(s)* assiduellement (815); à fin que nous *recongnoissions* l'autheur, et *magnifions* sa benignité (819).

To recapitulate, we have noted through examples: (1) the primary subjunctive endings *-ons* and *-ez*; (2) the influences producing the secondary subjunctive endings *-ions* and *-iez*;

(3) the persistence of the primary endings in the so-called imperative forms; (4) the further persistence of these primary endings in subjunctive clauses, owing to the imperative forms' passing from parataxis into hypotaxis; (5) the earlier failure to distinguish between forms in direct and indirect quotations; (6) the phonetic explanations frequently applicable, at all stages; (7) the final stage of the persistence of *–ons* and *–ez* as subjunctive endings, when they become attributable either to a yod in the stem of the form or to erratic orthography.

We may now add the opinion that, from a syntactical viewpoint, the final adoption of the endings *–ions* and *–iez* is not attributable to an intention to differentiate between indicative and subjunctive moods, but between imperative and subjunctive moods, in accordance with the change from parataxis to hypotaxis. This opinion is substantiated by the fact that the differentiation is accompanied contemporaneously by a change to the generalized employment of optative or hypotactic *que*, and that thereafter in prose only a few old stereotyped cases of optatives without *que* remain in usage. The modernly so-called imperative forms were left isolated and distinguishable when the endings *–ions* and *–iez* were adopted in hypotactic construction, but not in parataxis.

The distinction of this imperative form came about through the syntactical development of the language and the attendant refinements leading to: (1) the distinguishing of indirect from direct quotations, and the distinguishing of special imperative or direct forms from dependent or indirect forms, that is, the distinguishing of dependent from independent construction, by the employment of distinctive verb forms in addition to a distinction in sentence structure; (2) the distinguishing of the conjunction *que* as a sign of dependent construction, and its employment even where no main verb preceded, as a syntactical symbol of a dependent or subjunctive form.

We may say that there are three stages of linguistic development corresponding to our authors: (1) There is established the habit of employing the same forms in both independent construction (optative or imperative forms) and dependent construction (optative or subjunctive forms), since these forms are so

frequently identical (Joinville); (2) The imperative forms (first and second persons, but not third) become distinguished from the subjunctive forms in the majority of verbs, but the syntactical habit persists, especially after verbs of entreaty, and we find the new imperative form in dependent clauses (Marg.); (3) The distinction of the new imperative forms from the new subjunctive forms becomes generalized, but its orthographical representation is still hindered by phonetic obstacles (Calvin).

So far as a moderate amount of research has enabled us to judge of the matter, the sixteenth-century tendency to re-Latinize orthography and the contrary tendency to simplify orthography on a phonetic basis, which was championed by one small school of grammarians and opposed by another, was without noteworthy effect on the present question.

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Calv.	Jean Calvin
Chr.	Chrétien de Troyes
Comm.	Philippe de Commynes
Desp.	Bonaventure Des Periers
Eutr.	Contes et discours d'Eutrapel
Fail	Noël du Fail
Froiss.	Jean Froissart
G.	Gargantua
Malh.	François de Malherbe
Marg.	Marguerite d'Angoulême
Mont.	Michel de Montaigne
P.	Pantagruel
Rab.	François Rabelais
R. C.	Institution de la religion chrestienne

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THE AMERICAN SCHOLAR: TWO VIEWS

ALBERT H. MARCKWARDT

OF THE many commencement addresses and Phi Beta Kappa orations which were delivered before rows of forbearing students during the fourth decade of the nineteenth century, at least two, with titles striking for their similarity, subsequently found their way into print. The earlier of these, *The Advantages and the Dangers of the American Scholar*,[1] was given by Gulian Crommelin Verplanck, on July 26, 1836, the day preceding the commencement exercises, at Union College, Schenectady, New York. Ralph Waldo Emerson gave the second address, *The American Scholar*,[2] a little more than thirteen months later, August 31, 1837, at the annual meeting of the Cambridge chapter of Phi Beta Kappa.

Verplanck, although now little known, presumably had the greater reputation at the time the addresses were delivered. A brief outline of his career up to this point will reveal the many interests and abilities of the man. Born in 1786, he was a man of fifty at the time of his address, and Emerson's senior by seventeen years. Like Irving, he prepared for law in the office of Josiah Ogden Hoffman, but the years 1821–25 found him occupying the chair of Christian Evidences and Moral Sciences at the New York Protestant Episcopal General Theological Seminary, and the author of a treatise on the evidences of Christianity.[3] The next eight years, 1825–33, he spent in Washington as a

[1] Verplanck, G. C., *The Advantages and the Dangers of the American Scholar* (Wiley and Long, New York, 1836). This address was overlooked in the list of published orations, addresses, and poems delivered or read before the college and its societies included in the *Historical Sketch of Union College*, prepared under the auspices of the Bureau of Education in 1876.

[2] Emerson, R. W., *The American Scholar* (Monroe, Boston, 1837).

[3] Verplanck, G. C., *Essays on the Nature and Uses of the Various Evidences of Revealed Religion* (C. Wiley, New York, 1824).

member of the House of Representatives. Here, as a member and later as chairman of the Committee on Ways and Means, he employed himself principally with the always difficult tariff problem. The crowning achievement of his congressional career was the enactment of a new copyright law giving additional security to the property of authors and artists in their works, more than doubling the term of legal protection to them, besides simplifying the law in various respects. As a man of letters, he was contemporary with the Irvings, Gouverneur Kemble, and Paulding. Early in his career he wrote in pamphlet form the *Letters of Abimilech Coody, Ladies' Shoemaker*, directed for the most part against De Witt Clinton and precipitating a sporadic and inconsequential literary warfare. "This war," says Bryant, "was closed by the publication of *The Bucktail Bards*, as the little volume is called, which contains *The State Triumvirate*,[4] *a Political Tale*, and *The Epistles of Brevet Major Pindar Puff*." [5] The last-named volume, however, is anonymous, and Verplanck may have written it with Rudolph Bunner, a scholar and man of wit, and possibly with John Duer, a colleague in the law. In the years 1828 30 he collaborated with Bryant and Robert C. Sands in *The Talisman*, one of the most praiseworthy of our early literary annuals. In 1833 a volume of his collected speeches appeared.[6] Later he was to undertake the arduous task of editing the Harper's Shakespeare of 1844–47.

The seventy-seven graduates of Union College, then, saw

[4] *The State Triumvirate, a Political Tale: and the Epistles of Brevet Major Pindar Puff* (New York, 1819).

[5] Bryant, W. C., "A Discourse on the Life, Character, and Writings of Gulian Crommelin Verplanck," *The New York Historical Society* (New York, 1870), p. 18. The title which Bryant gives the book is taken from the *Prolegomena* of the little volume, purporting to have been written by a Scriblerus Busby. *The State Triumvirate*, p. 3, says: "Gentle and Right Learned Reader, Behold, I present to thee a complete and not inelegant edition of all the opera minora of Poetae Bucktailici, being the works of the Bucktail Bards. . . ." For a long time the anti-Clinton faction in New York called themselves "Bucktails," the name arising from the insignia of the Tammany Society, a portion of the tail of a deer, worn in the hats of the members. The book itself, however, bears the title *The State Triumvirate*.

[6] Verplanck, G. C., *Discourses and Addresses on Subjects of American History, Arts, and Literature* (J. and J. Harper, New York, 1833).

before them a sturdy Knickerbocker in the middle of a highly varied and by no means unsuccessful career, but the Cambridge men were confronted, to use the words of Bliss Perry, by a "tall, thin man of thirty-four," for whom "illness and private sorrow had been added to professional chagrin," and who "had settled down in Concord to make a scanty living by lecturing and occasional preaching."[7] The subsequent history of the Emerson address is well known. Five hundred copies of the printed edition were sold in less than a month, whereas most of the original issue of *Nature* lay untouched upon the bookseller's shelves. Carlyle felt that he had heard a "man's voice" in the distant West, and Holmes was later to hail the speech as our "Intellectual Declaration of Independence."[8] Although the latter description is considered at present to be somewhat inexact and unduly extravagant, *The American Scholar* has remained, nevertheless, one of Emerson's best-known and best-loved essays. Verplanck's discourse is read only by "meek young men in libraries."

One of the questions that naturally arise at the very outset of this discussion is whether or not Emerson knew of Verplanck or of his address at Schenectady. There seems to be no mention of Verplanck in Emerson's *Journals* until 1864, when he was included in a list of guests to be invited to the Shakespeare Centennial program of the Saturday Club.[9] His name does not appear on the list of guests present at this occasion,[10] nor does Emerson record a written reply to the invitation. However, the *Journals* do indicate that Emerson was in New York in 1834, from October 18 to November 5, that he was paying close attention to the political situation and the fall elections, and that,

[7] Perry, B., "Emerson's Most Famous Speech," *The Praise of Folly and Other Papers* (Houghton Mifflin Company, Boston, 1923), pp. 89–92. This essay gives some idea of the number of times the subject of American scholarship had been treated by commencement speakers at Harvard alone.

[8] Holmes, O. W., *Ralph Waldo Emerson* (Houghton, Mifflin and Co., Boston, 1885), p. 115.

[9] Emerson, E. W., and Forbes, W. E., *Emerson's Journals* (Houghton, Mifflin and Co., Boston, 1910), X : 21; April, 1864.

[10] Emerson, E. W., *The Early Years of the Saturday Club* (Houghton, Mifflin and Co., Boston, 1918), p. 339. The list mentioned above was furnished to E. W. Emerson by Mrs. James T. Fields and is believed to be correct except for the omission of Cabot's name.

among other speakers, he heard Philip Hone, a wealthy business man and Whig leader, who was at least a political friend of Verplanck's.[11] At this time Verplanck, recently returned from Washington, was acclaimed on all sides for his success with the copyright law, an accomplishment which must have interested Emerson. He had been nominated for mayor by the Whigs the previous spring and had been defeated only after a stirring contest. Thus in view of the close attention he gave to the fall campaign, it scarcely seems that Emerson could not have heard of Verplanck. The two men may even have met, but there is not the least ground to suspect that Emerson knew of the Union College discourse, or that he was at all influenced in his own address by the older man.

To make such a claim is far from the purpose of this paper, yet the similarity of subject matter and the proximity in point of time of the two addresses does invite a comparison of the ideas contained therein. Moreover, the speakers afford an engaging contrast in personality, which is heightened by a complete reversal of their contemporary and their present reputations. Did the two men see American scholarship beset with the same dangers and pitfalls? Did they advocate the same remedies? What is there about Emerson's essay which has given it a permanent place in American literature while Verplanck's has been consigned to a dusty oblivion?

This type of comparison may best be made here by following the outlines of Verplanck's address, since Emerson's simple and concise plan is familiar to most readers and easily kept in mind. Emerson begins by defining the scholar as Man Thinking; he then designates the three major influences upon him as Nature, The Past, and Action; finally, he specifies the duties of the scholar and closes with a glance at the contemporary situation. The broad outlines of Verplanck's discourse are indicated by its complete title. First of all the "blessings and advantages" of the American Scholar are considered, next, "their accompanying dangers," and finally, "their attendant duties."[12]

[11] *Emerson's Journals*, III : 350–359.
[12] Verplanck, *American Scholar*, p. 8.

There is little in Emerson's oration to correspond to the first of Verplanck's three divisions. Where Emerson acidly describes the public mind of his own time as a "sluggard intellect" concerned with nothing better than exertions of mechanical skill, "too busy to give to letters any more," [13] Verplanck cheerfully asserts: "We all know and feel that everything in the conditions and prospects of our country tends to excite and maintain a bold and stirring activity of thought and action throughout the whole community." [14] He views improvements calculated to raise the physical standard of living with less apprehension than does Emerson and seems not to feel with him that these matters may easily assume a momentary importance greater than they deserve and that they may detract the scholar's attention from more fundamental objects. The graduates of Union College were told to rejoice because, "With us, commerce, arts, agriculture, enterprise, adventure, ambition, are crowding and hurrying every man forward. Our past is but brief, we can scarcely be said to have a present . . . we are all pressing and hastening forward to some better future. No single mind can well resist the general impulse. The momentum of the whole mass of society, composed of myriads of living forces is upon each individual, and he flies forward with accelerated velocity; without any power over his own motion than that of the direction of its course. The universal ardor is contagious, and we all rush into the throng of life, and are swept along by its broad resistless current." [15]

Secure in his optimistic view of contemporary conditions, Verplanck continues in much the same tone. Books, newspapers,

[13] Emerson, R. W., "The American Scholar," *The Complete Works of Ralph Waldo Emerson* (Centenary ed., Boston, 1903), I : 81. All future references will be to this edition of Emerson's works.

[14] Verplanck, *op. cit.*, p. 9. In his second Phi Beta Kappa address, "The Progress of Culture," delivered in 1867, Emerson, like Verplanck, views the situation more optimistically. "Was ever such coincidence of advantages in time and place as in America today?" *Works*, VIII : 207.

[15] Verplanck, *op. cit.*, p. 10. Cf. *Emerson's Journals*, IV : 85; Sept. 13, 1836: "What age was not dull? When were not the majority wicked? or what progress was ever made by society? Society is always flat and foolish. The only progress ever known was of the individual." See also IV : 158; Nov. 28, 1836: "I see plainly the fact that there is no progress of the race, that the progress is of individuals."

and magazines scattered throughout the land disseminate the acquisitions of learning, particularly science, removing the latter from its lofty pedestal and making it "an exalted and munificent benefactor constantly and profusely contributing to our welfare and happiness." As a result, there are "here no prejudices in favor of time honored usages . . . strong enough to resist the advance of scientific improvement or wise innovation." [16] He admits the possibility that the utilitarian attitude toward scholarship prevalent in this country may result in retrogression in some of the more abstruse and subtle forms of intellectual endeavor. "If we must lose them, let us be content, and the more so, because their deprivation . . . is more than compensated by countervailing benefits resulting from the same cause. Such acquirements or accomplishments cannot flourish here, because they require the devotion of the whole man to their service, whilst the American man of letters is incessantly called off from any single inquiry, and allured or compelled to try his ability in every variety of human occupation." [17] In a certain sense this statement may be interpreted as an *Apologia pro Vita Sua*, since Verplanck himself, as the foregoing sketch of his life plainly indicates, was constantly tempted "to try his ability in every variety of human occupation."

This trend of thought leads Verplanck in his next step to come to a conclusion similar to one of Emerson's, although for a wholly different reason. "No man of informed mind can with us exclude the surrounding world, . . . no professional student or practitioner can remain the mere man of books." [17] To illustrate his contention, Verplanck points to the great men of antiquity, none of them solitary scholars ". . . contented with the half wisdom of books alone"; he further mentions Bacon, Franklin, Spenser, Shakespeare, Scott, Milton, Da Vinci, and Michelangelo as men of mixed pursuits, of familiar intercourse with actual life.

All of this, of course, bears some similarity to Emerson's discussion of Action as an influence upon the scholar. He declares: "I do not see how any man can afford, for the sake of his nerves and his nap to spare any action in which he can partake. . . .

[16] Verplanck, *American Scholar*, pp. 15–17. [17] *Ibid.*, p. 21.

The true scholar grudges every opportunity of action past by, as a loss of power." [18]

Verplanck closes his discussion of the conditions propitious to scholarship by pointing out that the innumerable shades of opinion held in this country upon religion, politics, literature, and other matters of momentous import habituate men to exercise independent judgment. The absence of hereditary rank and literary patronage frees the intellect from undesirable bonds of servitude.[19] Throughout the whole first portion of the address Verplanck expresses a confidence in the public mind that Emerson does not seem to have felt at this time, no matter what his views regarding the ultimate possibilities of human achievment may have been.

It is when Verplanck turns to the dangers confronting American scholarship that we feel a closer kinship between the views of the two men. The first danger seen by Verplanck is "that of a conceited smattering superficiality in consequence of that very universality of occupation and inquiry which seems, in other respects, so propitious to the formation of a sound, comprehensive understanding. . . . It shows itself in the capacity of talking fluently upon all things, and of doing everything badly. . . . It nourishes and sustains itself upon compends, abridgments, extracts, and all other convenient subsidia of improved education. . . . You may trace it by the small pedantry that commonly accompanies half knowledge." [20] Although Emerson says little directly concerned with superficiality, his strictures upon the inactivity of the public mind,[21] his caution against pedantry when he speaks of books as an influence on the scholar, and, above all, his remark that it is the duty of the scholar never to defer to the popular cry,[22] are eloquent revelations of his feelings on the subject. He expressed himself even more clearly in a cryptic sentence from his Journal some four years previous to this address. "In this world if a man sits down to think, he is immediately asked if he has a headache?" [23]

[18] Emerson, *Works*, I: 95.
[19] Verplanck, *op. cit.*, pp. 27–40.
[20] *Ibid.*, pp. 41–42.
[21] Emerson, *Works*, I: 81, 87, 114.
[22] *Ibid.*, I: 101.
[23] *Emerson's Journals*, III: 207; Sept. 16, 1833.

Although the prosperity of the country is a condition generally favorable to the welfare of the American scholar, Verplanck acknowledges that the manifold opportunities to gain sudden wealth or political power often tempt the ambitious youth to look with disgust upon the slow returns of regular labor, whether in study or in business.[24] This leads to another consequence which he is inclined to admit only in part, "that in America the practical and profitable swallow up every thought, that fancy withers, art languishes, taste expires; the mind looks only to the material and mechanical, and loses its capacity for the ideal and the abstract; the sensuous is vigorous, the pure reason is torpid and blind." [25] Emerson, too, sees this country possessing a mind which, "taught to aim at low objects, eats upon itself," [26] slow to open to the "incursions of Reason." [27] But nowhere does Verplanck attain the vindictiveness of Emerson, who calls upon the scholar to "resist the vulgar prosperity that retrogrades ever to barbarism," [28] and who complains that public and private avarice make the air we breathe thick and flat.[29] On the other hand, Verplanck seems somewhat of an economic opportunist, assuring the scholar that, although the unfriendly task of observation is his, it need not necessarily be an unpaid one: "I am far from advising a timid abstinence from any creditable or honest undertaking that may offer strong inducements to enter upon it." [30]

In the next of the perils to scholarship as seen by Verplanck, there is again a strong similarity between the ideas of the two men. Almost at the very beginning of his address Emerson declares: "Our day of dependence, our long apprenticeship to the learning of other lands draws to a close. The millions that around us are rushing into life, cannot always be fed on the sere remains of foreign harvests. Events, actions arise that must be sung, that will sing themselves." [31] At the close he reiterates: "We have listened too long to the courtly muses of Europe. The spirit of

[24] Verplanck, *American Scholar*, p. 44.

[25] *Ibid.*, p. 47. He admits only that "to this [materialism] there are . . . stronger temptations than in other countries."

[26] Emerson, *Works*, I: 114.

[27] *Ibid.*, I: 89. [28] *Ibid.*, I: 101. [29] *Ibid.*, I: 114.

[30] Verplanck, *op. cit.*, p. 46. [31] Emerson, *Works*, I: 81–82.

the American freeman is suspected to be timid, imitative, tame." [32] Likewise Verplanck decries the student, "familiarized from youth with the glories and beauties of European literature," who "is early fired to imitate or to rival its excellence, though the exploits and projects he forms be incongruous with the state and taste of his country." [33] He pictures the embryo author projecting epics; the artist designing Raphael-like historical compositions; and the orator striving to rival Pitt, all of them unable to realize their dreams because their genius is imitative rather than original. Thus they become misogynistic and anti-republican. He points to Joseph Dennie as an example of the man of talent who knew the contempt of his countrymen because he chose to imitate rather than to create, and bids the student heed the warning of his great and single error.

Verplanck finally cautions the graduates of Union College against the dilatory effects of slavish devotion to the spirit and ideals of partisanship. He assigns the rise of this evil to majority rule. "Connected with all this," he says, "and as a most essential ingredient in the system, a bitter spirit of intolerance is nursed up, unjust to the motives of adversaries, degrading to public men, and engendering narrow jealousies among the people. . . . I have even feared that this spirit of intolerance and dictation was extending itself from the political into the social and religious world." [34] In contrast to Verplanck's urbane and somewhat evasive manner, Emerson treats the matter of party adherence with his characteristic courage and brevity. "Is it not the chief disgrace in the world not to be an unit; — not to be reckoned one character; — not to yield that peculiar fruit which each man was created to bear, but to be reckoned in the gross, in the hundred, or the thousand, of the party, the section, to which we belong; and our opinion predicted geographically, as the north or the south?" [35]

Both men dwelt briefly upon the attendant duties of the American scholar and in both cases they are, as Emerson put it, "comprised in self-trust." [36] Self-reliance, of course, was Emer-

[32] *Ibid.*, I: 114.
[33] Verplanck, *op. cit.*, p. 51.
[34] *Ibid.*, p. 58–60.
[35] Emerson, *Works*, I: 115.
[36] *Ibid.*, I: 100.

son's panacea for all of the ills of the world, and in this light Verplanck's closing sentence is striking for its similarity. "Be true to yourselves and to your country." [37] Verplanck for the second time in his address felt the necessity of urging his hearers to eschew the life of the recluse. "Let them [our youth] not think to keep themselves pure by holding themselves aloof from action. Let them take their stand manfully as their own best judgment may dictate, in the political and religious divisions of our people; but let them feel for those who honestly differ from them as erring brethren." [38] Emerson is equally certain that the opposite course is the proper one, that it behooves the scholar to keep aloof from the ephemeral bickerings of humanity. "Some great decorum, some fetish of a government, some ephemeral trade or war, or man, is cried up by half of mankind and cried down by the other half, as if all depended upon this particular up or down. The odds are that the whole question is not worth the poorest thought which the scholar has lost in listening to the controversy." [39]

It is not difficult to reconcile these two diametrically opposed bits of advice. Verplanck's is offered with the purpose of giving immediate assistance to a social order suffering from an overdose of provinciality and Jacksonian democracy, in need of sympathetic aid from a superior culture. Emerson feels that the scholar will be unable to give ear to the promptings of the Oversoul, if his thoughts and actions are on a level with the Understanding. Verplanck sees the gratitude of posterity to the well-rounded man and his influence in public affairs during his lifetime as rewards for his versatility and energy, whereas Emerson regards action purely as a moral discipline, as a part of the essential equipment of the scholar, and carefully cautions him not "for the sake of wider activity, [to] sacrifice any opinion to the popular judgments and modes of action." [39]

Nature, which Emerson considers the first influence on the scholar, seems to have no place in Verplanck's scheme. The fact that Emerson's entire outlook rested on a consistent and profound philosophy, combining the world of men, the world of nature, and

[37] Verplanck, *American Scholar*, p. 62. [38] *Ibid.*, p. 60.
[39] Emerson, *Works*, I: 100–102.

the Creator into a unified whole, accounts in part for the superior quality of the Harvard address. This philosophic background justifies his concluding advice — rely upon yourself — and seals it with the stamp of inevitability. Verplanck, although his conclusion is similar and as sound, is still the lecturer, not the teacher, and his peroration has the tone of good words well spoken.

It is a definite indication of the state of American scholarship during the early decades of the nineteenth century that both men saw exactly the same pressing problems: subservience to foreign scholarship, an encroaching materialism, and the tendency to allow the contemporary political squabbles to detract from a disinterested search for truth.

Bliss Perry has shown that other Harvard speakers had, from time to time, pointed out the same evils.[40] But they presented other and more superficial solutions, such as increased endowments or raising the standards of undergraduate scholarship. Nor were discussions of the duties and opportunities of the American scholar confined to purely academic occasions. Dr. William Ellery Channing, writing on the same topic, rather inconsistently advocated "a more extensive acquaintance with the intellectual labors of Continental Europe" as a means of escaping the dominance of European culture. It is significant that we find both Emerson and Verplanck falling back upon fundamental strength of character. It is to be expected, of course, in the case of Emerson, the man who had resigned his pastorate of the Second Unitarian Church rather than administer Communion, a rite in which he felt he could not believe. Strangely enough, there are incidents in Verplanck's life which bear a striking similarity. In his early

[40] Perry, B., "Emerson's Most Famous Speech," *The Praise of Folly and Other Papers*, pp. 97–101. This essay is confined to the discussion of the Harvard speeches. De Witt Clinton, in a Phi Beta Kappa address before the Union College chapter in 1823, decried the "intellectual vassalage of this country" and its "idolatrous veneration for the literary men of Europe," but, like the Harvard speakers discussed by Bliss Perry, concluded that "whatever may be our thoughts, our words, our writings, or our actions, let them all be subservient to the promotion of science and the prosperity of our country." Campbell, W. W., *Life and Writings of De Witt Clinton* (New York, 1849), pp. 356–363.

twenties he was charged with, and found guilty of, creating a public disturbance in an attempt to defend a Columbia graduate whom the college authorities refused a diploma because of a politically liberal speech made on commencement night.[41] Later in his political career he voluntarily killed his chances for a fifth term in Congress by refusing to equivocate regarding the United States Bank.[42] Again, in 1841 he withdrew from his second nomination for mayor rather than alter his views on state support for parochial schools, wherein he differed radically from most of his party.[43] Even in his seventies his adherence to the unpopular Democratic party cost him the presidency of the Century Club, which he had held for some years.[44] So far as acting upon the courage of his convictions is concerned, Verplanck need not suffer by comparison with the author of the *Divinity School Address.*

To recapitulate, then, Emerson and Verplanck, both men of steady courage viewing the plight of the American scholar, saw him beset by the same dangers and recommended self-reliance as the best possible means of combating the situation. A few differences in their attitudes, minor but none the less pertinent, remain to be accounted for. The earlier portions of Verplanck's address are marked by an optimistic outlook which is singularly lacking in Emerson. Several possible explanations for this discrepancy suggest themselves. Emerson was thirty-four, fired with the impetuous zeal of youth, his career and place as a prominent factor in American thought still ahead of him. Verplanck in his thirties had been equally zealous and almost as picturesque,

[41] Bryant, W. C., *Life of Verplanck*, pp. 16–17.

[42] *Ibid.*, p. 32: "The Democratic party desired to re-elect Mr. Verplanck, if some assurance could be obtained from him that he would not oppose the policy of the Administration in regard to the bank. That party understood very well his merits and his usefulness, and made a strong effort to retain him, but *he would give no assurance even to pursue a neutral course*, and accordingly his name was reluctantly dropped from their list of nominations. A long separation ensued between him and those who up to that time had been his political associates." Italics mine.

[43] Nevins, A., *The Diary of Philip Hone* (Dodd, Mead & Co., New York, 1927), II : 569.

[44] Wilson, J. G., *Memorial History of the City of New York* (New York, 1893), IV : 244.

if somewhat less profound, in his assault against the obvious injustices of "things as they are," but at the age of fifty he shared the general tendency toward conservatism which so often comes with advancing years. He had attained a recognized position in life, honored by his fellow-countrymen perhaps to a degree beyond his ultimate value, whereas Emerson "at thirty, in the face of his broken career considered sadly the exploits at his age of Alexander, Scipio and Hannibal." [45]

What wonder, then, that the older man, his ideals influenced by his economic well-being, should find fewer faults with the general scheme of existence? Emerson, having evolved and set forth his transcendental philosophy in *Nature,* was only now prepared to judge the social and political order about him in the light of those ideals. The late Professor Parrington explained his state of mind at this time in these words: "The ideal he had drunk was a perennial condemnation of the material." [46] Moreover, Verplanck in all his public utterances was far more the conventional orator, and doubtless thought it good psychology to pat his audience on the back before telling them their shortcomings.

In Emerson the absence of the patriotic note, interpolated by Verplanck, suggests, I believe, the wider range of Emerson's ideas. The vision of the transcendentalist was not hedged in by national boundaries. He was interested in a world-soul, not merely in national intellectual aggrandizement. Likewise, it has already been suggested that Emerson's transcendentalism is responsible for the extreme individualism of his address, which is found wanting in the earlier speech.

The reasons, then, for the superiority of Emerson's address are self-evident. His was an essay backed by a consistent philosophy, a broader vision, a finer idealism than that of the older man. It is expressed in a terse, pungent manner; his illustrations are striking because of their concreteness. Verplanck's style is at

[45] Michaud, R., *Emerson the Enraptured Yankee* (Harper & Bros., New York, 1930), p. 91.

[46] Parrington, V. L., *The Romantic Revolution in America* (Harcourt, Brace and Co., New York, 1927), p. 390.

times turgid; his sentences move in a heavily labored fashion and his diction seldom rises above the conventionalities of the average "distinguished speaker." So far as literary merit is concerned there obviously can be no quarrel with the decree of Fame.

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SOCRATES IN THE FRENCH LITERATURE, WITH A FEW OTHER REFERENCES

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THE present paper has for its point of departure a famous passage in Jean-Jacques Rousseau's *Émile*, in which Christ is contrasted with Socrates. This contrast has moved us to undertake a study of the esteem in which Socrates was held by French writers before Rousseau as well as by Christian thinkers of the Middle Ages.

The passage in question ends as follows: "What prejudices, what blindness must one be guilty of to be so bold as to compare the son of Sophroniscus to the son of Mary. What distance separates the one from the other! . . . Yes, if the life and the death of Socrates are those of a sage, the life and death of Jesus are those of a god." [1]

In 1769 Voltaire answers Rousseau directly, and, probably seeking to be disagreeable, seems to assign to Christ a rank below that of Socrates. He says: [2] "Socrates died the sage, Jesus is depicted by his disciples as fearing death. I know not what hollow-brained writer, what lover of contradictory paradoxes has taken it into his head to say that Jesus died a god. Has he seen any gods die? Do the gods die? I don't believe that the author of so much rubbish has ever written anything more absurd."

But at moments when he was less obsessed by his antipathy for Rousseau, Voltaire found it within him to be more just to Christ. He even preferred him to Socrates in a new parallel he draws between those two figures, because Jesus foresaw and desired his death. Voltaire says: [3] "He was afraid, and yet he sacrificed himself; that is greatness."

[1] Rousseau, J. J., *Émile*, *Œuvres* (1762, Édition Hachette), IV : 280.
[2] *Dieu et les hommes*, *Œuvres* (Édition Moland), XXVIII : 208.
[3] *Traité sur la tolérance*, *Œuvres* (1762), XXV : 86–87.

Voltaire, however, always admired Socrates; he even venerated him: witness his *Loi naturelle* (1752), in which he exclaims:[4] "Do you think that Socrates, Plato, . . . cherished names, sacred names you have never read about, were surrendered to the fury of demons by a beneficent God whose image they were?"

In 1767 Voltaire wrote of Jesus as follows:[5] "He was an upright man. . . . He was the Socrates of Galilee, a rustic Socrates."

In the *Profession de foi des théistes*[6] (1768) Voltaire makes another comparison between Jesus Christ and Socrates. He considers them alike in virtue envisaged from the point of view of natural religion.

A tragedy by Voltaire, entitled *Socrates*[7] (1759), was never acted, but in a letter addressed to Saurin he showed that Socrates was the complete embodiment of the philosopher as conceived by the eighteenth century, and he added that the royal power sought to treat the Encyclopaedists in the manner in which Socrates had been treated in his own day.

Indeed, it was the proud boast of the Encyclopaedists that they followed Socrates, that they sought to resemble him. When they referred to Diderot as "The Philosopher" they intended that appellation to mean the "French Socrates."[8] For them, even as for Socrates, the value of all study lay in its usefulness. Like the sage of antiquity, they extolled the effort to arrive at a knowledge of man in order to derive therefrom a lay system of morals. Like him, they attacked all superstition, and their philosophy, like his, was condemned as detrimental to public morality and as a menace to social institutions. In spite of the opposition of the powers that be, they, like him, persist in their efforts to bring about what they believe to be the good of humanity. The critic Suard, whose work shows little originality, but who

[4] *Œuvres*, XII : 170.

[5] *Homélie sur l'interprétation du nouveau Testament*, *Œuvres*, XXVI : 353.

[6] *Œuvres*, XXVII : 69.

[7] *Œuvres*, XL : 365–396. Letter, May 5, 1760.

[8] Voltaire called Diderot "Socrates"; see *Œuvres*, XLIV : 358. Letter, July 23, 1766. In a speech before the French Academy Thomas compared D'Alembert to Socrates. See Voltaire, *Œuvres*, XLV : 66. Letter, January 28, 1767.

because of that very fact expresses well the ideas current among his friends the Encyclopaedists, describes the work of Socrates in the following manner:[9] "Before Socrates neither nature nor the force of virtue seems to be known, and people had no idea of what is just and unjust. Socrates it is, then, who was the first to teach human beings that it is from man's very nature that his actions must be deduced. He, therefore, is the one who created a true system of morals."

Jean-Baptiste Rousseau (1670–1741), who was considered by his contemporaries the greatest French poet of that time, extols Socrates to the disadvantage of Alexander the Great.[10] "The famous conqueror of the Euphrates," he writes, "would, in the rôle of a Socrates, prove himself the most commonplace of mortals."

Marquis d'Argens[11] mentions with admiration the *Sancte Socrates ora pro nobis* of Erasmus. Diderot[12] does the same thing in his *Essai sur les règnes de Claude et de Néron.* Moreover, in describing the use of pantomime, Diderot[13] lovingly sketches the last scene of a drama on the death of Socrates.

In Sauvigny's tragedy *La Mort de Socrate* (1763), which enjoyed a great success, Crito eulogizes Socrates in the following terms: "Imitator of the eternal and supreme Being . . . he conquered hearts by dint of his virtue."

After attacking Voltaire's *Socrate* because "this divine Socrates says nothing divine," Grimm writes,[14] apropos of Sauvigny's tragedy, that the author ought to have "shown Socrates in all his sublimity, inspired, stirred by his daemon as he developed before the Areopagus all the principles of his divine philosophy."

About the year 1761 Nicolas Fréret discusses and also deifies Socrates in his *Observations sur les causes et sur quelques circonstances de la condamnation de Socrate.* Two years later Mably[15] adds: "You will have me remember Socrates; but the cup of hemlock which will be the eternal dishonor of your fathers did

[9] *Variétés littéraires,* IV : 392.
[10] *Ode VI, À la fortune.*
[11] *Lettres juives* (738), II : 140.
[12] *Œuvres* (Édition Assézat), II : 188.
[13] *Essai sur la poésie dramatique, Œuvres,* VII : 377–387.
[14] *Correspondance,* V : 287. Letter, May 15, 1763.
[15] *Entretiens de Phocion* (1763), pp. 59–60.

not trouble his repose. What a long succession of calamities could have been predicted for a city blind and corrupt enough to inflict capital punishment upon Socrates' virtue."

Baron d'Holbach shares the sentiment just cited. He says:[16] "Socrates, who carried to the point of fanaticism his submission to the laws of an ungrateful and frivolous people, who wanted to undergo martyrdom, was unjust to himself. If he had consented to leave his prison he would have spared the Athenians a crime which covered them with eternal infamy."

In the second volume of his *Histoire ancienne* (1777) Condillac says of Socrates:[17] "He it is, then, who first diverted men's minds from the quest of things useless, not within the scope of our intelligence, and brought them to the meditation of things useful — things within our reach. It is this that is responsible for the statement that through him philosophy had descended from heaven upon earth. He was a true Prometheus."

During the revolutionary period Socrates represents Reason in revolt against Superstition, and Condorcet writes:[18] "The death of Socrates is an important event in human history. It was the first crime which signalized the war between philosophy and superstition. . . . It pained the priests to behold men . . . seeking to perfect their reason. . . . Hypocrisy frightened hastened to accuse philosophers of impiety towards the gods. . . . Socrates could not escape their blows. . . . His hatred for the Sophists, the zeal with which he brought back a philosophy that had strayed from its path to a consideration of objects more useful, showed the priests that truth alone was the object of his intellectual pursuits . . . that he wanted . . . to teach men to make use of their reason; and among all the crimes this is the one which a priestly pride can least forgive."

The eighteenth century, which was preëminently one of ideas and in conflict with religious traditions, was to take especial interest in Socrates and make him the subject of many plays. Here is a list of them:

[16] *La Morale universelle* (1776), II: 62–63. [17] *Œuvres*, X: 159.
[18] *Esquisse d'un tableau historique des progrès de l'esprit humain*, *Œuvres*, VI: 66–67.

Voltaire, *Socrate* (1759);
Sauvigny, *La Mort de Socrate* (1763);
Linguet, *Socrate* (1764);
Ducis, *La colère de Xanthippe* (1781);
Raynouard, *Socrate dans le temple d'Aglaure* (performed in 1804);
Bernardin de Saint-Pierre, *La Mort de Socrate* (published in 1808);
L-S. Mercier, *La Maison de Socrate* (performed in 1809).

Although Fontenelle's *Dialogues des morts* is of the year 1683, we put this writer in the eighteenth century, owing to his great influence on the thought of the period. In the *Third Dialogue* [19] Montaigne meets Socrates in the Elysian Fields and says to him: "So it is you! divine Socrates. How overjoyed I am to see you! I have just arrived in this land and from the very moment of my arrival here I began to look for you." In the *Jugement de Platon sur les dialogues des morts* of the same author [20] Socrates likewise holds a preponderant place.

The admiration for Socrates was general all over Europe. In 1716 an anonymous English author wrote a tragedy, not performed, entitled *Socrates Triumphant, or the Danger of Being Wise in a Commonwealth of Fools*, and Amyas Bushe was author of a work called *Socrates, a Dramatic Poem* (1758). We have, moreover, counted as many as nine editions on Socrates published in Germany between the years 1716 and 1789. Grimm [21] announced the translation of a book by a German author entitled *Le Socrate rustique* which, amidst the delights and innocence of a pastoral setting, describes the life of a Swiss peasant, a philosopher without knowing it.[22]

In the seventeenth century the skeptic La Mothe Le Vayer speaks highly of Socrates in *Les cinq dialogues de Tubero* (1630). In *Le dialogue sur le sujet de la vie privée*,[23] Hésychius envies An-

[19] *Œuvres*, IV : 421.
[20] Fontenelle, *Œuvres*, IV : 91–137.
[21] *Correspondance*, V : 189. November 15, 1762.
[22] Addison thought of Socrates before he decided to take "Cato" as the subject of his tragedy. Goethe often mentioned his intention of choosing Socrates for a drama. In one of his moral essays Benjamin Franklin advises us to imitate the humility of both Jesus Christ and Socrates, and, in so doing, he puts them on the same plane.
[23] *Œuvres*, I : 208.

tisthenes because the latter "has found in this honest poverty the greatest and truest riches that exist, riches that Socrates had taught him to value. . . . To spend one's days without interruption beside a Socrates, to listen to his charming words, to consider his lofty actions, to draw important lessons from the least of his gestures . . . that, Philoponus, is a summary delineation of the good and the useful." Elsewhere, Le Vayer adds:[24] "This evil domestic demon [Xanthippe], the poverty of his family, the ill nature of his children, did not cause Socrates to be untrue to his nature; for all that, he was Socrates none the less." The author's admiration for Socrates is further attested in his *De la vertu des païens*, published in 1642.

G. Naudé, one of the most distinguished scholars of the time, discusses Socrates and his *daemon*. He says:[25] "As for me, I think that it may truthfully be said that this familiar daemon of Socrates . . . was nothing other than the happy rule of his life, the wise manner in which he acted, the experience he had of things, and the result of all his virtues which fashioned in him the prudence that may rightfully be called the luster and spice of all acts . . . or, to put it in one word, the art of living. . . . So that, with greater appearance of truth, we may believe that the soul of this philosopher, cleansed as much of its more violent passions as it was enriched by all sorts of virtues, was the true daemon of his conduct . . . and if to this we added that all his actions were good, and that he had no purpose other than to guide his fellowmen along the paths of virtue, I think that there can be no justification for concluding that this spirit was an evil daemon. . . . That is likewise the reason why he [Socrates] was considered the eighth sage of Greece."

In 1632 there appeared a book by Guez de Balzac entitled *Le Socrate chrétien*. It is a work of Catholic apologetics explained by a new Socrates who, the author declares, possesses all the qualities of the ancient Socrates, for they have in common the same virtues.

[24] *Dialogue sur le mariage, Œuvres*, II : 368–369.

[25] *Apologie pour tous les grands hommes qui ont esté accusez de magie* (1625), pp. 226–227.

In his *Voyage dans la lune* (1656), an important work, the ideas of which influenced Swift and Voltaire, Cyrano de Bergerac takes as guide the famous daemon of Socrates, diversely interpreted as the revelation of intelligence, judgment, and reason, or as the inward divinity of the conscience, all of which is to the lasting honor of the philosopher.

The *Épître dédicatoire au Dauphin*, which stands at the head of the first edition of the *Fables* (1668) of La Fontaine, mentions the fact that it "would be truly desirable that hands other than mine had added to them the delights of poetry, since the wisest of the ancients, Socrates, considered that they were not useless." [26] In the *Préface*, speaking of fables and apologues, La Fontaine says,[27] further, that they represent "something so divine that several personages of antiquity have attributed the larger parts of these fables to Socrates, thus selecting to serve them as father the man who among all the mortals communicated most with the Gods." He mentions the "good Socrates" in the *Paysan du Danube*, and one of his fables on *La Maison de Socrate* [28] contains the following line reminiscent of the philosopher's answer to those who found his dwelling too small: "The good Socrates was right."

Racine, in one of the prefaces of his *Phèdre* [29] (1677), reminds the reader that "Socrates, the wisest of philosophers did not disdain putting his hands to the tragedies of Euripides." In a copy of Plato's *Banquet*,[30] annotated in the margin, are to be found the following words written in Racine's own hand: "Socrates is original and resembles no one."

The *Abrégé des vies des anciens philosophes*, by Fénelon,[31] assures us "that a virtue as pure as that of Socrates could not fail to elicit our admiration. . . . It is difficult to understand how a man who led everybody to praise the gods and who exhorted young men to flee from vice could have been condemned as impious and as a corrupter of youth. This crying injustice could have occurred only in times of disorders."

[26] La Fontaine, *Œuvres* (reimpression of 1883), I : 2–3.
[27] *Œuvres*, I : 15.
[28] *Œuvres*, I : 333.
[29] *Œuvres*, III : 303.
[30] *Œuvres*, VI : 269–270.
[31] *Œuvres*, III : 290.

La Bruyère defends himself against his adversaries by identifying himself with Socrates. He declares:[32] "It has been said of Socrates that he was delirious, that he was a madman full of wit, but those of the Greeks who spoke in this manner of a man so wise were [themselves] considered madmen."

Only two satirists of the seventeenth century, Mathurin Régnier and Boileau, view Socrates with some disfavor and strike a dissonant note in the chorus of widespread admiration. Régnier in his second *Satire* says:[33] "As for Socrates, the oracle [reason] is quite doubtful in connection with him. . . . We are not at all sure that, as he went about philosophizing, he did not force his unchaste attentions upon young Alcibiades." The poet continues his attack in the tenth *Satire*[34] by calling Socrates "a mangy spirit that delights to scratch itself, to idolize and admire itself, to go about proclaiming itself in honeyed words, one of the ineffable beauties of heaven." None the less, Régnier does not excuse the censors of Socrates.

Boileau, also, doubts the philosopher's moral purity. He says:[35] "And what indeed was Socrates, the honor of Greece the profane, when closely examined, but a mortal by his nature predestined to evil; and despite the virtue of which he made so great a show, a very doubtful friend of young Alcibiades."

In the sixteenth century Socrates achieves great eminence. There is a celebrated passage in the *Colloquies* of Erasmus[36] in which Nephale, one of the personages of the *Dialogue*, taking as a basis for his remarks the life of Socrates, exclaims before all his hearers: "Those are admirable sentiments for a man who knew neither Christ nor the Scriptures, and so it is that in reading such things about such men, I can't keep from exclaiming: Sancte Socrates ora pro nobis!"

The impression produced by this passage must have been very great, since Jean Bodin's *Heptaplomeres* reiterates it about the year 1593. In this work by the famous author of the *Républi-*

[32] *Les Caractères*, *Œuvres*, VI: 269–270.
[33] *Œuvres* (1613), p. 13.
[34] *Œuvres*, p. 77.
[35] *Satire sur l'équivoque* (1705).
[36] *Repas religieux*, *Œuvres*, I: 123.

que, Toralba, who represents the thought of Bodin, repeats with the approval of everybody: "I am not far from singing Sancte Socrates ora pro nobis," and he compares Socrates with Jesus Christ somewhat to the advantage of the former. He also affirms that human virtue suffices to win eternal rewards, and he places Socrates in Paradise directly on the right of the Lord, with Plato and the just of antiquity after Socrates.[37]

Rabelais celebrates Socrates in his *Gargantua*[38] (1542): "Most illustrious drinkers, . . . Alcibiades in the dialogue of Plato entitled the Banquet praising his preceptor Socrates who was without controversy the prince of philosophers . . . says that he was like the sileni. . . . But opening this box you would have found a celestial and priceless drug, a more than human understanding, a marvelous virtue, an invincible courage, a sobriety without its like, an unfaltering contentment, a perfect assurance, an incredible contempt for all these things for which human beings lie awake, run about, labor, sail the seas, and fight." His *Cinquième livre*[39] further eulogizes Socrates, saying that he was "the first to bring philosophy from heaven down upon earth and to make of the idle and curious thing it was, something useful and profitable."

Even our great skeptic Montaigne is stirred with enthusiasm the moment he has to speak of the one he calls "the good and great Socrates, the master of masters."[40] "The soul of Socrates," he writes, "is the most perfect that has come to my knowledge. I doubt much that any like it ever existed."[41] For Montaigne, "Socrates was the perfect exemplar of all great qualities,"[42] and he "was informed that the God of wisdom had attributed to him the name of Sage."[43] Montaigne continues:[44] "I can easily conceive Socrates in the place of Alexander, but Alexander in that of Socrates, I can not."[45]

Tabourot des Accords, poet and author of *Bigarrures et Touches*

[37] VI : 601–602.
[38] *Prologue de l'auteur*, *Œuvres*, I : 1.
[39] I : 82.
[40] Montaigne, *Essais* (edition of 1580), I : 137, III : 223.
[41] *Ibid.*, II : 129.
[42] *Ibid.*, III : 197.
[43] *Ibid.*, II : 233.
[44] *Ibid.*, III : 269.
[45] Our skeptic discusses also the daemon of Socrates in his *Essais*, L : 56.

(1584), says in one of his poems entitled *Le Magnifique*,[46] directed against the Courtiers and Mignons of the Court of France: "They would do better if they resembled the sileni of old which, like Socrates, were ugly on the outside but beautiful within."

Zwingli, the Swiss Protestant reformer, the Florentine academicians, the preacher Maigret, the humanist Castellion in his *Traité des hérétiques* (1554), rescue from limbo the pagan saints and Socrates first.

In the Middle Ages Jehan de Meung, author of the second part of the *Roman de la rose*, about 1275, causes all-powerful Reason to address the lover as follows:[47]

No count of fortune and her wheel
(Not worth a prune is she) but steel
Thy heart like Socrates, who ne'er
In all his life was swayed by her,
She smiled, his heart grew nowise gay;
She frowned, he laughed her frown away.
Whatso of good or ill he met,
Was each 'gainst each in balance set,
Nor deigned he say that this was good,
Or that was fraught with drearyhood.
No evil chances could destroy
His peace, nor good luck move to joy.
Of all who loved was he the man
Judged by Apollo Pythian
For wisest, as Solinus saith,
For ne'er could Fortune's changeful heart
Alter his visage — still 'twas seen
In joy unmoved — in woe serene.
And even when, because quoth he
"There is but one great Deity"
They brought to him the poison cup
Calmly he drank the potion up.

In another place in the poem Reason says to the lover:[48]

In thine heart
Bethink thou well of Socrates
(Too wise a foolish world to please)
My love I gave him, and to me
He gave all his love utterly.

[46] *Bigarrures et Touches* (edition of 1662), p. 33.

[47] *Le Roman de la rose*, vss. 6173–6194. The translation is by F. S. Ellis, *The Romance of the Rose* (J. M. Dent & Co., London, 1900).

[48] *Ibid.*, vss. 6528–6532.

Abélard's *Théologie chrétienne* [49] proclaims that between the great philosophers, pagan and Christian, there is little or no real difference, for they have all been divinely inspired. He believes that Socrates and Plato — Socrates is always placed first — will be saved.

Moreover, in their writings most of the Church Fathers and Doctors have saved Socrates. According to the tradition of the Greek Fathers, the apostles descended into the infernal regions to rescue the Gentiles who had lived virtuously and, there again, Socrates is the first to be saved. Theophilus of Antioch, Origen, Clement of Alexandria, Diodorus of Tarsus, Eusebius of Caesarea, and the Greek writer Diogenes Laertius in his *Lives, Doctrines and Maxims of Illustrious Philosophers*, praise Socrates very highly and seek to make of him a Christian. The *Apology* of Saint Justin states that Socrates was a Christian because he knew in part the thought of Christ, and Tertullian, one of the most celebrated doctors of the Church, admits that the great pagans, Socrates to begin with, then Plato and Aristotle, had a natural Christianity which he calls: *Testimonium animae naturaliter Christianae.* The *Monologium* of Saint Anselmo saves the great pagans, Socrates first of all, and Saint Paul expresses the same idea when he says that God would not condemn a virtuous pagan to whom the law of Jesus Christ had not been revealed: *Quicumque sine lege peccaverunt, sine lege peribunt.* The *Summa Theologica* of Saint Thomas Aquinas, the angelic doctor, discusses Socrates at length and takes his daemon to be intelligence; Saint Thomas adds that Socrates, fleeing evil and following natural reason, had probably received from God, by an inward inspiration, the truth necessary for salvation. Indeed, we see only Saint Augustine, patron saint of the French Jansenists, condemning all the pagans and Socrates implicitly in the following words, which sound like a death knell: "It is tolerance that is cruel since non-Catholic belief of any kind involves eternal punishment."

Certain interesting points emerge from this necessarily incomplete study. The comparison between Christ and Socrates is made four times by Voltaire, once by Jean-Jacques Rousseau,

[49] II : 406.

and once by Bodin. Montaigne and Jean-Baptiste Rousseau compare Socrates and Alexander the Great to the detriment of the latter.[50] The comparison of Socrates with the sileni is found in Plato's *Banquet*, in the work of Rabelais, and in that of Tabourot des Accords. Fontenelle, Voltaire, Fréret, Grimm, and Sauvigny deify Socrates, and Cicero, Rabelais, and Condillac acknowledge that Socrates had brought philosophy from heaven down upon earth. The *Sancte Socrates ora pro nobis* is successively employed by Erasmus, Bodin, Diderot, and D'Argens. Plato, Xenophon, Aristotle, Solinus, Jehan de Meung, Montaigne, Rabelais, Naudé, La Fontaine, and Racine mention that Socrates was nominated by the Pythian Apollo as the wisest of men, or they call him the eighth sage of Greece, the prince of philosophers.[51]

With the exception of two satires, French thought and literature seem to have seen in Socrates the man who had most honored the human being and who had rendered the greatest services to morals and humanity.

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[50] Marcus Aurelius Antoninus does the same in the *Meditations*, VIII [3] (*Harvard Classics*, II, p. 257).

[51] Diderot also stresses this point in the *Bijoux indiscrets* (1748; edition of 1920), p. 152.

SOME RELATIONS BETWEEN HENRY VAUGHAN AND THOMAS VAUGHAN

ARTHUR J. M. SMITH

AMONG the most difficult and fascinating productions of the so-called metaphysical poets of the seventeenth century are those poems of Henry Vaughan in which the Anglican physician has put forward his conception of magnetism as a vast operant in the universe. The poet who is recognized as an intense and genuine mystic possessed an eager scientific curiosity and a taste for philosophical speculation that led him to find material for poetry in a variety of natural phenomena and, indeed, to undertake original scientific research.[1] The hibernation of bats and dormice, for instance, is frequently referred to in both the prose and verse, and its significance as a type and miniature of the resurrection forms the basis of a good deal of interesting speculation.[2] Two natural phenomena with which Vaughan seems to have been much preoccupied are those of instinct and of magnetism, and he considered them as being, in all essentials, one. Instinct was the application of magnetism to the organic world, so that the cock crowing at dawn and the flower turning to the sun were instances of a divine attraction similar to that which draws the lodestone toward the north. References to terms that appear to be used with an almost technical precision — terms

[1] See "Vanity of Spirit," *The Works of Henry Vaughan*, edited by Leonard Cyril Martin (Oxford, 1914), II : 418:

> "I summon'd nature: peirc'd through all her store,
> Broke up some seales, which none had touch'd before,
> Her wombe, her bosome, and her head
> Where all her secrets lay a bed
> I rifled quite. . . ."

[2] See "Man in Darkness," *ibid.*, I : 176–177, and "Resurrection and Immortality," *ibid.*, II : 400.

such as "line," "sense," "stone," and "magnet" — are scattered among Vaughan's poems with a definiteness of purpose that calls for interpretation. Among the more important poems dealing with this group of ideas are the following difficult ones: "Sure, there's a tye of Bodyes!" [3] "The Starre," [4] "The Queer," [5] "Ascension-Hymn," [6] and "Cock-Crowing," [7] and more or less incidental references to such terms may be found in almost a score of poems. The purpose of this paper is to suggest an interpretation of some obscurities in these poems by relating Henry Vaughan's conception of magnetism to the Platonic and hermetic speculations of his brother Thomas Vaughan.

Henry Vaughan recognizes two types of attraction, of which he speaks in terms of magnetism. The first is a mutual attraction operating between the visible temporal universe and its eternal counterpart existing in the mind of God. This is an action of the soul, and its end is perception. The second is an influence acting through the senses and flowing along certain well-defined lines by means of which individual souls can join themselves to the harmony of the world-soul and through its medium communicate, though separated by wide distances. This is primarily a bodily function, dissipated by death and resulting in sympathy, not perception. It will be seen that there is a strong affinity here with the teachings of the Scholastics and the hermetic Platonists. These ideas have, however, been derived largely from the writings of Thomas Vaughan.

In the stanzas called "The Starre," [8] Henry Vaughan gives an account of the first, and more purely Platonic, of these two kinds of influences. The poet thinks of the beauty of the star as having been called into being by the attraction of a beauty "here below." Like attracts like, so that heavenly beauty seeks out its earthly type.

[3] Vaughan, Henry, *op. cit.*, II : 429.
[4] *Ibid.*, II : 489. [5] *Ibid.*, II : 539. [6] *Ibid.*, II : 482.
[7] *Ibid.*, II : 488. This poem has been shown to contain a number of remarkable parallelisms to the thought and phrasing of Thomas Vaughan. See Judson, A. C., "The Source of Henry Vaughan's Ideas concerning God in Nature," *Studies in Philology*, 24 : 592–606.
[8] Vaughan, Henry, *op. cit.*, II : 489.

. . . bodies once infected,
Deprav'd or dead, can have with thee
No hold, nor sympathie.

In whatever earthly object attracts the star Vaughan postulates a restless, pure, unquenchable, and immovable desire:

These are the Magnets which so strongly move
And work all night upon thy light and love,
As beauteous shapes, we know not why,
Command and guide the eye.

For where desire, celestiall, pure desire
Hath taken root, and grows, and doth not tire,
There God a Commerce states, and sheds
His Secret on their heads.

With this whole poem we should compare, in addition to the two passages cited by Professor Martin, the following paragraph from Thomas Vaughan's *Magia Adamica:*

Heaven here below differs not from that above but in her captivitie, and that above differs not from this below but in her libertie. The one is imprisoned in the matter, the other is freed from the grossness and impurities of it, but they are both of one and the same Nature so that they easily unite; and hence it is that the superior descends to the inferior to visit and comfort her in this sickly infectious habitation.[9]

The idea of the descent of the superior to the inferior is expressed also in the verses:

And still the lesser by the best
And highest good is blest.

In order to follow clearly the relations between the ideas of the two brothers it will be necessary to consider the more detailed exposition which is given in the prose writings of Thomas Vaughan. Those which concern our present purpose are connected with the triune nature of God, with the function of each Person in the creation and preservation of the world, and with the bond that exists between the temporal and eternal worlds. It will be found

[9] P. 119. All references to the writings of Thomas Vaughan are to *The Magical Writings of Thomas Vaughan,* edited by Arthur Edward Waite (London, 1888). This includes *Anthroposophia Theomagica, Anima Magica Abscondita, Magia Adamica,* and *A Perfect and Full Discoverie of The True Coelum Terrae.*

that Thomas Vaughan speaks of a magnet and of magnetic lines in connections that throw light on some verses of Henry Vaughan that have not, so far as I know, been satisfactorily explained.

The conception of the Trinity to be found in the magical books of Thomas Vaughan follows the teachings of orthodox Scholasticism.

> God the Father is the Metaphysicall, Supercelestiall Sun, the Second Person is the Light, and the Third is "Fiery Love," or a Divine Heate proceeding from both.[10]

God the Father is a transcendent source, whereas the Son and the Holy Ghost are immanent in the universe as the light and the heat which stream from the fountain of Godhead and suffuse the whole fabric. This threefold aspect of the deity was not always manifested thus. ". . . God before his work of creation was wrapped up and contracted in himself." [11] The creation, indeed, is looked upon by Thomas Vaughan as the acquirement by the transcendent God of a new property, that of immanence.

The universe thus possesses significance because it is an extension of the power of God. Such a view does not, however, in the case of either of the brothers, lead to a crude pantheism. Thomas Vaughan speaks of "the Great World . . . above all which God himself is seated in that infinite, inaccessible Light which streames from his own nature." [12] And again: ". . . above the heavens God is manifested like an infinite burning world of light and fire, so that hee overlooks all that he hath made" — so far the transcendent God, the First Person of the Trinity. His simultaneous immanence in the other two Persons is implied in the clauses that continue the sentence and tell how "the whole fabric stands in his heat and light, as a man stands here on earth in the Sun-shine." [13]

How far this conception is removed from an identification of the universe with God may be observed in a number of passages in the writings of either of the brothers, but nowhere more strik-

[10] *Anthroposophia Theomagica*, pp. 11–12.
[11] *Ibid.*, p. 12.
[12] *Ibid.*, p. 27.
[13] *Coelum Terrae*, pp. 142–143.

ingly, perhaps, than in the dedicatory lines to Henry Vaughan's *Silex Scintillans* where, making use of a similar metaphor, the poet goes on to ask:

> If the Sun rise on rocks, is't right,
> To call it their inherent light? [14]

Thomas Vaughan employs another figure — a common Platonic one — to express his conception of God in nature. God is in the world as an image is in a mirror: "God in love with his own beauty frames a Glasse to view it by reflection." [15]

The visible universe created for such a purpose was built according to no haphazard whim. It was modeled upon another world which God had conceived in the eternity of his imagination. "Meditation," Thomas Vaughan noted, "forerunns every solemne worke. . . . There is . . . in God something analogicall to it." He quotes Iamblichus to the effect that "the Gods did conceive within themselves the whole design before they generated it," and declares that the true God did likewise: "God in his Æternall Idea foresaw that whereof as yet there was no materiall copy. The goodnesse and beauty of the one moved him to create the other." [16] In *Coelum Terrae* Thomas Vaughan quotes from the *Cabala* a similar idea: "The Building of the Sanctuarie which is here below is framed according to that of the Sanctuarie which is above," and comments upon it, emphasizing the implied Platonism. "Here," he writes, "wee have two worlds, visible and invisible, and two universall natures, visible and invisible, out of which both those worlds proceeded." [17]

There is, however, a firm bond between these two worlds, and this it is which Thomas Vaughan names as "the Universall Magnet which binds this great frame and moves all the members of it to a mutual compassion." [18] The intensity of this force or magnet is due to the fact that the visible universe is the material and temporal symbol of God's eternal idea: ". . . there is an Universall Agent, who when Hee was disposed to create had no other patterne or exemplar whereby to frame and mould his creatures

[14] Vaughan, Henry, *op. cit.*, II : 395.
[15] *Anthroposophia Theomagica*, p. 5.
[16] *Ibid.*, p. 11. [17] P. 125. [18] *Ibid.*

but himself, but having infinite inward ideas or conceptions in himself, as Hee conceived, so He created that is to say, Hee created an outward forme answerable to the inward conception or figure of his mind." [19]

Thomas Vaughan refers time and again to these two worlds, the world of sensation and its eternal counterpart in the mind of God. In *Magia Adamica* the imperfections and corruptibility of the temporal world are considered defects inherent in the "sign" as compared to the "thing signified." "The material, corruptible shadow," he writes, "is not the object of faith, but the spiritual, æternall prototype which answers to it, and makes the dead figure effectual." [20] All things have their counterpart in eternity, and there is a mutual attraction between the temporal object and its divine idea. He refers to the *Cabala* for an instance of "the Invisible, Archetypall moone, by which our visible cœlestiall moone is governed and imprægnated." [21] The archetypal perfect man in whose image Adam was created is the Second Person of the Trinity, who was incarnated as Christ; and, since the symbol approximates the thing signified, all men are "a little Incarnation." [22]

This conception of the universe as the symbolic representation of God's eternal Idea finds no such definite expression in the poetry of Henry Vaughan, but it is the general philosophic framework into which his theories of terrestrial and heavenly magnetism may be fitted for the purpose of interpretation. There is, the poet feels, a natural affinity between each created thing and the mind of its Creator. Implanted in the creature is a fundamental desire for union with the perfection of which it is the image, a desire which acts as an attracting force between the world of temporal visibles and the invisible eternal perfection. These are the ideas we have already noted in "The Starre." The force of "celestiall, pure desire" is clearly this "Universall Magnet" which Thomas Vaughan sees as the unifying and moving spirit of the universe. It is referred to again in the verses entitled "The

[19] *Anthroposophia Theomagica*, p. 125.
[20] *Magia Adamica*, p. 97. [21] *Ibid.*, p. 92.
[22] *Anthroposophia Theomagica*, p. 23.

Queer," [23] and here he speaks of it, as the mystics most often have done, as Love and Holiness:

> Sure, *holyness* the *Magnet* is,
> And *Love* the *Lure*, that woos thee down. . . .

The conception of a less spiritual attraction outlined in "Sure, there's a tye of Bodyes!" is not unrelated to this instinctive bond between temporal objects and divine ideas. Each is an instance of the same divine energy. Thomas Vaughan recognizes this, and refers to "the infallible Magnet, the Mystery of Union," by which "all things may be attracted, whether physicall or metaphysicall, be the distance never so great. This is Jacob's ladder; without this there is no ascent or descent, either influentiall or personall. . . . This answers to God the Son, for it is that which mediates between extremes, and makes inferiors and superiors communicate," [24] Again, in *Anima Magica Abscondita* he writes: "For there is in Nature a certain chain, or subordinate propinquity of complexions between visibles and invisibles, and this is it by which the superiour, spirituall essences descend, and converse here below with the matter." [25] That this chain and the influence which passes along it are looked upon as magnetic seems to be quite clearly shown in the following sentence that sketches a magnetic field with the definiteness of a Gilbert: "The cœlestiall virtue [the "superiour spirituall essences" of the preceding quotation] penetrates all the elements along invisible lines which, starting from all points, meet at the earth's centre. . . ." [26] It is by utilizing this terrestrial magnetism that the soul "by an union with universall force" can "infuse and communicate her thoughts to the absent, be the distance never so great." [27]

In this mixture of metaphysics, mysticism, and science there is much that appears to have been incorporated into the poetical musings of Henry Vaughan. We find there a similar conception of a magnetic force operating along a definite line to join those who are separated from one another. In the opening lines of "Sure,

[23] Vaughan, Henry, *op. cit.*, II : 539.
[24] *Anthroposophia Theomagica*, p. 20.
[25] P. 50. [26] *Ibid.*, p. 66.
[27] *Anthroposophia Theomagica*, p. 31.

there's a tye of Bodyes!" there occurs the most precise expression of these ideas, which, however, fails to make an impression on the average reader because of the remoteness of the allusions and the cryptogrammatic quality of the writing:

> Sure, there's a tye of Bodyes! and as they
> Dissolve (with it,) to Clay,
> Love languisheth, and memory doth rust
> O'r-cast with that cold dust;
> For things thus *Center'd*, without *Beames*, or *Action*
> Nor give, nor take *Contaction*, . . .
>
> Absents within the Line Conspire, and *Sense*
> Things distant doth unite. . . .[28]

The poet is referring here to some such line of terrestrial magnetism as Thomas Vaughan has described. The "tye" is one which operates through the senses, and its power dies when the body dies. It might be objected at this point that, whereas Thomas Vaughan has been referring to a power of the soul, Henry Vaughan is speaking of a sensual bond. Some further reading in Thomas Vaughan will resolve the difficulty. Thomas Vaughan holds that the soul has two spheres of activity, one spiritual and one natural or sensual, and when he says that the soul can unite herself with the soul of the world to communicate with Absents he is referring to the natural sensational function, to the "tye of Bodyes." Indeed, after describing this power of the soul, he makes it quite clear that the other and more spiritual attraction cannot be expressed in words. "I omit to speak of her Magnet [the soul's], wherewith she can attract all things, as well spiritual as natural."[29] There is, further, an illuminating passage in *Anthroposophia Theomagica* which shows how fundamental a part is played by the body in linking the individual soul to the soul of the world, and thus putting it into communication with those magnetic lines of influence through which "things distant" can "unite":

> As the Great World consists of three parts — the Elemental, the Coelestial, and the Spiritual, . . . even so man hath in him his earthly, elemental parts,

[28] Vaughan, Henry, *op. cit.*, II : 429.
[29] *Anthroposophia Theomagica*, pp. 31–32.

together with the coelestial and angelical natures, in the center of all which moves and shines the Divine Spirit. The sensuall, coelestial, æthereal part of man is that whereby we do move, see, feel, taste, and smell, and have a commerce with all material objects whatsoever. It is the same in us as in beasts, and it is derived from Heaven, where it is predominant, to all the inferiour earthly creatures. In plain terms it is part of the Soul of the World, commonly called the Medial Soul, because the influences of the Divine Nature are conveyed through it to the more material parts of the creature. . . . By meanes of this Medial Soul, or Æthereal Nature, man is made subject to the influence of stars . . . this spirit is in men, in beasts, in vegetables, in minerals. . . .[30]

It is, in other words, through the function of the body that the soul is able to tap the divine energy of the earth — the *Anima Mundi* of the Platonists. There is a "tye of Bodyes" because it is through the senses only that the soul can "have a commerce with all material objects." "Absents within the Line Conspire" by putting themselves into communication through the soul of the world and along those lines which Thomas Vaughan described as "starting from all points" and meeting "at the earth's centre."

There is a reference to this same magnetic line in Henry Vaughan's poem "Ascension-Hymn":

> Man of old
> Within the line
> Of *Eden* could
> Like the Sun shine
> All naked, innocent and bright,
> And intimate with Heav'n, as light.[31]

The conception here expressed of Eden as a place or state in which man was in more intimate communion with the Godhead and fount of light is connected with another group of ideas which the two brothers held in common, namely, their ideas concerning the close bond existing between God and man in the state of innocence, and their ideas of the nature and consequences of Adam's fall. The Garden of Eden, according to Thomas Vaughan, must be regarded as the symbol of a state rather than as an actual place, and he looks upon the account given of it in the Bible as being "amongst other mystical speeches contained in Scripture." [32]

[30] *Anthroposophia Theomagica*, p. 27.
[31] Vaughan, Henry, *op. cit.*, II : 483.
[32] *Anthroposophia Theomagica*, p. 26.

The following sentences should be compared with the lines just quoted:

> Man in the beginning (I mean the substantiall inward Man), both in and after his creation, for some short time, was a pure Intellectual Essence, free from all fleshly, sensuall affections. In this state the *Anima*, or Sensitive Nature, did not prevail over the spirituall as it doth now in us. For the superior mentall part of man was united to God "by an essentiall contact," and the Divine Light being received in, and conveyed to, the inferiour portions of the Soul, did mortifie all carnal desires, insomuch that in Adam the sensitive faculties were scarce at all imployed, the spirituall prevailing over them in him, as they do over the spirituall now in us. Hence we read in Scripture, that during the state of innocence he did not know that he was naked. . . .[33]

Here we have all the essential ideas of the stanza from the "Ascension-Hymn" — the nakedness and innocence of Adam and the close instinctive union of man in Eden to the divine light. This latter aspect is expressed elsewhere and more concisely by Thomas Vaughan, when he writes in *Magia Adamica:* "It is the constant opinion of the Hebrewes that before the Fall of Adam there was a more plentifull and large communion between Heaven and Earth, God and the Elements, than there is now in our days." [34]

"Sure, It was so," agrees Henry Vaughan, "Man in those early days Was not all stone, and Earth." The whole poem "Corruption," indeed, is an amplification of the ideas which were originally derived by Thomas Vaughan from the Bible and the *Cabala*. It was not only man, however, as is several times repeated throughout *Silex Scintillans*, who suffered by the Fall:

> He drew the Curse upon the world, and Crackt
> The whole frame with his fall.[35]

All created things were his enemies, "for that Act That fel him, foyl'd them all." [36] The bent palm-tree "now shut from the breath And air of *Eden*, like a male-content . . . thrives no where." [37] And so, too, we read in Thomas Vaughan, that the curse "was intended chiefely for man, who was the only cause of it, but [it] extended [also] to the elements. . . . For if God had excluded him [man] from Eden, and continued the earth in

[33] *Anthroposophia Theomagica*, p. 36.
[34] Pp. 91–92.
[35] Vaughan, Henry, *op. cit.*, II : 440.
[36] *Ibid.*
[37] *Ibid.*, "The Palm-tree," II : 490.

her primitive glories, he had but turned him out of one Paradise into another, wherefore he fits the dungeon to the slave, and sends a corruptible man into a corruptible world. But in truth it was not man, nor the earth alone, that suffered this Curse, but all other creatures also. . . ." [38] Adam regarded himself as "a felon and a murderer," he writes, "being guilty of that curse and corruption which succeeded in the world because of his fall, as we have sufficiently proved out of the Mosaicall and Cabalisticall traditions." [39]

The similarity of view traced here would be found on more extended inquiry to embrace a wide field. On nearly all the fundamental problems of religion and philosophy Henry and Thomas Vaughan were in close accord. But interesting as this accord may be, its real significance is in the light it throws on the difficulties which confront the modern reader of Henry Vaughan's beautiful religious poems. It seems likely that any new understanding of the more metaphysical of these poems will come as a result of carefully comparing them with the works of Thomas Vaughan and of such writers as Cornelius Agrippa, Hermes Trismegistus, Dionysius the Areopagite, and the various Cabalists and Platonists who influenced Thomas Vaughan so profoundly.

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[38] *Magia Adamica*, p. 94. [39] *Ibid.*, pp. 94–95.

RENAISSANCE AND BAROQUE INFLUENCES IN GOETHE'S DRAMAS

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THE study of the dramatic works of any writer quite naturally involves consideration of the well-established and accepted dramatic models or patterns of his time, upon which he bases his own early attempts and to which he must go to study and learn the technique of his art. After years of effort and application he finds as a rule the form most suitable for the expression of his own genius, if his work is at all effective, and the prime object of any art is of course to present or express itself clearly and effectively in its materials.

In this paper we propose to examine very briefly Goethe's tendencies as a dramatist in the light of the great examples of dramatic form which served him as patterns and upon which he drew in varying degree in the course of his own artistic development. We are not to interest ourselves in what he has to say, nor indeed in how he says it — nor in his views of life or mastery of language. We are interested only in the particular form of dramatic art which he chooses, and in why he chooses it.

The three great examples of dramatic art and form with which Goethe was acquainted and which served him as patterns were (1) the Greek drama, (2) the French classic drama, and (3) Shakespeare. He read them all, studied them, patterned after them at various times and in varying degree, and struggled to assimilate them into a new dramatic form consistent with his own genius. Of them, the French masters claimed him first. He tells us that he read Corneille and Racine in his father's library, Racine from cover to cover, memorizing many a long and favorite passage and being carried away frequently by the music of the words.[1]

[1] See *Goethes Sämtliche Werke*, Jubiläums-Ausgabe, 22 : 104, 127.

Not until his college days in Strassburg in 1770, when he sat at the feet of Herder, did he come to realize the significance of the genius of Shakespeare. It is true, Lessing's valiant battle to liberate the German drama from a deadening worship of rule and form did not seem at first to arouse Goethe particularly. Lessing was a child of the "Enlightenment," and the principal aim of his battle for Shakespeare seems to have been to prove that the latter, whom he celebrated as the great model in the drama for the Germans, also observed in his own way the most essential of the three unities of Aristotle, without which, of course, his opponents contended there could be no dramatic art. Lessing was a rationalist and in his criticism used the weapons of his age, but he did not reveal to his countrymen the universality of Shakespeare's poetic genius. That was to be Herder's share in the story of Shakespeare's conquest of Germany. He discovered Shakespeare the poet and presented him in historical perspective, for Herder's world, unlike Lessing's, was dynamic, evolutionary. Art to him was not a matter of observance of eternal rule, but an expression of life in a given civilization in a given time and place. He became the liberator of the "Storm and Stress" (*Sturm und Drang*), as Goethe became its foremost creative artist.[2] Goethe's first great drama, *Götz von Berlichingen*, in its original form (1771) was written in imitation of Shakespeare, but as early as 1779 in the first prose version of *Iphigenie* we find him back again using in the main the simple, restrained, balanced form of the French classic drama. The principal patterns which guided him in his efforts to master dramatic form were (1) the French classics, above all Racine, and (2) Shakespeare. His attempts to pattern after Greek dramatic form need not be considered here.

In 1915 Heinrich Wölfflin published his now famous book, *Kunstgeschichtliche Grundbegriffe*,[3] a study of the leading tendencies and essential differences between the art of the Renaissance of the sixteenth century and that of the baroque of the seventeenth century. He had previously made public in brief the results of

[2] See Gundolf, Friedrich, *Shakespeare und der deutsche Geist* (Bondi, Berlin, 1914).

[3] Sechste Auflage (Bruckmann, München, 1923).

his investigations, which were finally summed up in this work, in a paper read in Berlin in 1912.

Wölfflin has envisaged in five categories the basic distinctions between the Renaissance and the baroque, as follows:

(1) The art of the Renaissance is linear and is characterized by distinct, clear outlines. That of the baroque is pictorial and is indistinct in outline.

(2) The Renaissance has surface, and objects have a tendency to be placed beside one another. The baroque has depth (perspective), and objects may be arranged behind one another.

(3) The Renaissance artist uses a closed form and adheres to generally accepted canons of good taste. He respects the rules and regulations of artistic form. The baroque artist uses an open form; he is willing to suggest things, to give us a fleeting glimpse of a world beyond that which he is immediately presenting. He shows a tendency toward breaking the generally accepted rules and canons of good taste and proper form.

(4) In the art of the Renaissance a striking characteristic is an ever-present emphasis upon harmony in variety, a sense of proportion and completion not only in the work as a whole, but in each individual part. The baroque is characterized rather by a sense of unity in variety, an emphasis upon a single and predominating motive, which becomes the central element about which the remainder is grouped or sketched. Not every individual part is rounded out to completion.

(5) The art of the Renaissance possesses an absolute clarity of vision; the lighting, so to speak, is so arranged that it falls upon all parts of the work alike. In the baroque, things are only relatively clear, the lighting being arranged from a certain angle or point, illuminating some parts at the expense of others, which are cast therefore into shadow.

Wölfflin uses the words "linear" and "tectonic" in regard to Renaissance art, and points out that works of this type are balanced symmetrically on either side of a central unit or line; the design is based upon vertical or horizontal (or both) lines of direction. For the art of the seventeenth century, the baroque,

he uses the words "pictorial" or "atectonic," and shows how works of this period have a tendency toward one-sidedness and are asymmetrical, and how the design is based largely upon diagonal lines of direction.

To help establish his theses he offers many very interesting examples from the painting, architecture, and sculpture of the periods. For our purposes one need only call to mind Raphael and Rembrandt. The "Sistine Madonna" may serve as an excellent model of the linear, tectonic, symmetrical, carefully balanced and proportioned Renaissance work, grouped with due attention to vertical and horizontal design about a central unit, with every part carefully rounded out and complete in itself. From Rembrandt let us select the well-known etching "Christ Healing the Sick," the so-called "Hundertguldenblatt." Characteristically, the central figure is placed a bit to one side of the central axis; balance is not obtained by careful and symmetrical grouping about it. The light is focused upon the central figure and to its right; the left is largely in shadow, with indistinct grouping of figures. Figures are placed behind one another; there are many of them, and not all are drawn with the same care and desire for completion. There is emphasis upon a central motive and meaning — the rest is suggestive. There are depth, perspective, and a glimpse into a larger world of shadow beyond that immediately presented, and the line of design is diagonal. With Rembrandt, in contrast to Raphael, we have pictorial, atectonic, asymmetrical form. Wölfflin cites as a very apt instance a seventeenth-century relief copy of Raphael's "Disputa," now in the National Museum in Munich, in which the central vertical line about which Raphael groups his figures in the original is moved decidedly to the left of center, so that the left half of the entire grouping is much shorter and consequently much more crowded than the other.

Wölfflin's categories have had far-reaching consequences in the study of the arts and the problem of form in the arts in present-day Germany. They were quickly and readily applied in the study of kindred arts, especially music and literature. Among literary scholars Oskar Walzel, of Bonn, was one of the first to find in them a distinct help in solving many of the knotty

problems of literary form which had puzzled him for a long time. He readily acknowledged his indebtedness to Wölfflin, and was the first to apply the categories quite openly and frankly to the study of the form of Shakespeare's dramas.[4]

In 1916 he published an article called "Shakespeares dramatische Baukunst" in the *Shakespeare Jahrbuch*. In Wölfflin's analysis of seventeenth-century art he finds a key to a clearer interpretation of the form of the Shakespeare drama, its looseness or openness, its irregularity and lack of balanced symmetry, its depth of background or perspective, its riot of color and sharply contrasting effects in light and shadow, of gayety and grief. Shakespeare's plays fit in with Wölfflin's baroque characteristics; they are pictorial, atectonic, and the line of design, so to speak, is diagonal, not vertical; they are not balanced about a central act or axis. Like the etching by Rembrandt, they have a tendency to one-sidedness; they seem crowded on one side; Acts I–III build up an action and reveal characters in action for us with design and movement; Act IV usually lags or is overcrowded with incident, and the leading character is generally inactive or absent from the stage. Act IV, like that portion of baroque painting which extends out and beyond the diagonal line, gives us interplay of light and shadow, perspective, glimpses usually of the bigger stage, the world of events and circumstances, upon which the actual drama plays and of which it is a part. Moreover, Shakespeare's drama is characterized by a sense of unity in variety. There is a distinct center of interest — certain characters, about which incident and personages are grouped, as, for example, Hamlet, Lear, Antony and Cleopatra, Romeo and Juliet. Many of the things which appealed so tremendously to the young enthusiasts of the "Storm and Stress" — and to the young Goethe — are thus seen to be elements of another type of artistic form, a type which at that time could scarcely be understood and appreciated by a generation whose entire training had insisted upon the inviolability of an art

[4] Walzel, Oskar, *Gehalt und Gestalt im Kunstwerk des Deutschen* (Berlin—Neu-Babelsberg, 1923); and *Das Wortkunstwerk* (Quelle und Meyer, Leipzig, 1926).

based upon Renaissance tendencies and traditions. Shakespeare seemed to Goethe in 1771 like a new world in which he might find a refuge and support for his own emotional and iconoclastic extravagances during the time when he was breaking the shackles of a rigid formal classicism.

Walzel is unwilling to fix the term "baroque" upon the form of the Shakespeare drama, because he fears an abuse of the term in literary scholarship, such as has characterized the use of the word "romantic." Nevertheless, in his analyses of *King Lear* and *Antony and Cleopatra* he skilfully fits the Shakespearean structure into the general patterns of baroque art, and finds in Shakespeare a basic feeling for form similar to that which characterizes the art of Rembrandt and Rubens. In his searching and self-tormenting studies in Shakespeare Otto Ludwig, the German realistic novelist and dramatist, very aptly compares the form of Shakespeare's dramas to that of the sonata;[5] this appealed to Ludwig because he was himself a gifted musician. A. W. Schlegel was nearer Wölfflin and Walzel, however, when he characterized the classic drama as being like sculpture and Shakespeare as being like painting.[6]

When we turn now to the French classic drama, particularly that of Racine, the other outstanding pattern which Goethe found at hand to study and to imitate, we find at once the characteristics of the Renaissance art of the sixteenth century, according to Wölfflin's categories. Here are dramas that are tectonic, linear, symmetrical in form, with careful balancing and grouping of character and incident about a central axis in the third act. Corneille and Racine give us works of exquisite finish and polish. Like Raphael's paintings, they have outline and design, dignity and repose, simplicity and directness. The light is thrown full upon them; part of the drama is not, so to speak, in the light and part in the shadow. The characters are few, and each has, on the whole, a distinct entity and a function to perform in the dramatic structure. The lines of design are

[5] Ludwig, Otto, *Werke* (Bong and Co., Goldene Klassiker Bibliothek, Vierter Teil), p. 57.

[6] Schlegel, A. W., *Vorlesungen über dramatische Kunst und Literatur* (Kurt Schroeder, Bonn und Leipzig, 1923), II: 115.

vertical and horizontal. Each drama is grouped about a central scene in the central or third act, and both Racine and his master Corneille were very careful to arrange the incidents of the dramatic movement so that they would occur in proper balance and proportion and would be well timed and spaced in regard to the central, vertical structure. There is distinct tendency toward "surface art"; there are no glimpses into a world stage in the background, no dramatic perspective and depth. There is emotional intensity and crisis in a closed and concentrated design. Carl Steinweg in his remarkable analyses of the dramas of Corneille and Racine, and especially of Goethe's *Iphigenie* and *Tasso* and the relation of them to Racine, a work which appeared in 1912,[7] uses principally architectural terms to present his material. His aim is to show that the aesthetic feelings of French classicism are based quite rationally upon a mathematical and an architectural basis. He finds that Corneille and Racine after him built their dramas by well-balanced grouping about Act III, that the central scene of each act in its turn serves as an axis for the act, and that oftentimes both Corneille and Racine, in order to preserve this symmetrical balance, quietly introduced scenes and incidents quite unnecessary and immaterial to the direct course of the action.

The great indebtedness of the German classic drama to the French classicists, Corneille, Racine, and Voltaire, especially in regard to artistic form, has never in my estimation been truly or justly acknowledged by German scholars. Schiller, whose classic dramas became patterns for most of the dramatic literature in Germany during the nineteenth century, owes as much to them as he does to Shakespeare or to the Greeks. And even though Lessing aimed his critical shafts at them, more particularly perhaps at their imitators, his own dramas are unthinkable without them. Both Goethe and Schiller made use of the French classic drama in their efforts to improve conditions on the Weimar stage. Goethe translated the *Mahomet* and the *Tancred* of Voltaire, and shortly before his death Schiller completed his translation of Racine's *Phèdre.*

[7] Steinweg, Carl, *Goethes Seelendramen und ihre französischen Vorlagen* (Max Niemeyer, Halle, 1912).

The influence of the drama of Racine is most evident, however, in Goethe's *Iphigenie,* in which Renaissance tendencies in form are used by him more perfectly than in any of his other works. We have in this work a grouping of scene and character about a central axis in Act III, and in many of the acts there is grouping about a central pivot and careful balancing obtained by skilful arrangement of dialogues about a soliloquy or soliloquies about a dialogue. The lines of construction are vertical and horizontal. The action is simple and direct and, as with Racine, highly emotional. The work is *ein Seelendrama,* and has linear, tectonic form, clarity, and repose. *Tasso* and *Egmont,* both of them completed shortly after Goethe's return from Italy, like the scenes added to *Faust* at this time, are constructed with a similar feeling for tectonic form.

Excepting the scenes in *Faust,* I find *Egmont* to be in this regard the most interesting and revealing of these dramas. Here we have a historical subject, a truly Shakespearean background, lending itself quite easily to every tendency of a more baroque treatment. But Goethe patterns quite carefully after Renaissance models. He uses what he has aptly called in another connection "concealed symmetry." He gives us perspective, depth, color, something of a larger panoramic stage setting with the march of soldiery, the movement of crowds, and ready change of scene. The drama seems irregular and somewhat dispersed in form, but it is constructed with an instinct for form and proportion that is quite surprising. Two scenes, each one quite independent of the other and yet united to it by subtle touches of atmosphere and common interest, form the central unit, the third act. Adjacent on either side in Acts II and IV are the "big" dramatic scenes of the play. Acts I and V quite naturally fall into place at either extremity of the construction. Each act, except Act III, opens with a folk scene which not only presents with varying degree of intensity the fate of the people, but also reflects the paralleling fate of the hero Egmont. In the latter part of the drama Goethe also uses a typical Renaissance grouping and balancing by means of soliloquy and dialogue. Each scene is complete in itself, like a bead on a string of beads. The work has harmony in variety,

and no part is emphasized at the expense of another. Even though Egmont may not be present in the scene he is its central motif. It was this very predominant character of repose and architectural grouping to which Schiller objected and which he sacrificed for theatrical effect in his stage version of *Egmont*. Goethe also groups his characters in the scene somewhat after the fashion of the French. They appear in pairs, as Klärchen and Mutter, Margarete and Machiavel, Egmont and Sekretär, Alba and Silva. Except for the folk scenes there are but few characters on the stage at a time; in the scenes of dramatic tension, simply Egmont and Oranien, or Egmont and Alba. In the folk scenes each individual is carefully and consistently delineated — there is finish even in detail.

Goethe's inherent inclination for Renaissance form also lies basic to Wilhelm Meister's criticism of the form of *Hamlet* and gives direction to his effort to reconstruct it. Wilhelm feels free to change, as he puts it, "the external relations of the persons, whereby they are brought from place to place, or combined in various ways, by certain accidental incidents." The very baroque elements of the drama, the looseness, irregularity, and diffuseness of Act IV, offend him most of all — and these he proposes to alter.

Goethe's revision and adaptation to the Weimar stage in 1811 of A. W. Schlegel's translation of Shakespeare's *Romeo and Juliet* [8] gives us, however, most valuable testimony of his intuitive tendencies for the Renaissance form of the drama. Out of a typically atectonic, asymmetrical dramatic construction, full of color and passion, of gayety, merriment, tears and tragedy, he builds a tectonic, balanced, proportioned drama. Shakespeare's lines of design are typically diagonal; the bulk of the grouping and movement is concentrated in Acts I-III; Acts IV and V are somewhat slow and extended. Goethe breaks this form of grouping. He rebuilds the work about a central axis in Act III, places his big scenes in Acts II and IV, reduces the number of scenes to twelve, omits many characters, and quite radically changes the characteristics of the nurse and of Mercutio. The nurse becomes simply an elderly confidante of Juliet, and Mercutio plays a similar

[8] *Goethes Werke* (Weimar edition), IX: 169.

rôle to the duke. His gay spirit becomes heavy and somewhat coarse. The Queen Mab speech is entirely omitted. But the most revealing change which Goethe makes lies in the manner in which he lifts the tragedy of the lovers out of the typically baroque setting into which Shakespeare had placed it. For Shakespeare's drama is not merely the tragedy of Romeo and Juliet; it is also, in the words with which Herder characterized all of Shakespeare's drama, *Weltbegebenheit und Menschenschicksal.* The deadly feud between the Capulets and the Montagues is a menace to the welfare of the state. Of this, Shakespeare keeps us aware from the first scenes of the play until the closing scene, where a reconciliation takes place over the dead bodies of the lovers. Goethe gives us merely the lovers' tragedy, based upon a family feud. Act I is a typical Goethean construction; it is in three parts: (1) the street before Capulet's house, where servants are singing as they decorate for the masked ball, (2) the inside at the dance, and (3) the garden scene. Act II gives us (1) the union of Romeo and Juliet in Friar Lawrence's cell, and (2) the street scene, duels, and deaths of Mercutio and Tybalt. In Act III, in which Shakespeare puts his big scenes, we find two scenes of repose, consummation, and preparation (as in *Egmont*): (1) Juliet learns of the death of Tybalt and banishment of Romeo, and (2) Romeo learns from Friar Lawrence of his own doom. Act IV plays in Juliet's room and the balcony opening upon the garden and gives us (1) her farewell and leave-taking of Romeo, and (2) her agreement with Friar Lawrence to take the sleeping potion. Act V gives us Romeo's return from Mantua and the death of the lovers in Capulet's tomb. The important scenes which Shakespeare places in Act III, the duel and the death of Tybalt (Scene 1) and the leave-taking of the lovers (near the close of the act), Goethe groups *about* Act III as the central axis, in Acts II and IV. The adaptation presents a dramatic structure and form quite close to the usual examples of the Renaissance tectonic drama. It is very similar to that of Goethe's *Egmont*, and is in every way typical of the manner in which he constructed his dramas.

We have sketched briefly Goethe's indebtedness to the dramatic patterns and models existing in his day, the French classic

drama and Shakespeare, and have observed how he followed an inherent bent toward the closed tectonic Renaissance type of construction. His most characteristic and best-formed plays were written before his friendship with Schiller enriched and deepened his knowledge and understanding of dramatic form, but all his dramatic efforts were henceforth simply variations of the basic structure of *Iphigenie*, *Tasso*, and *Egmont* — even the *Faust*, in its individual parts and as a whole. It is true that these works have been frequently and severely criticized as lacking in theatrical effect. Schiller, who was always perfectly at home in the theater, was among the first to point this out, and seemed to be always ready to revise them and adapt them for the stage. But the truth is that they have won out on the German stage against all efforts at revision by lesser spirits. *Egmont*, as played in its original form, is always effective, as are *Iphigenie* and *Tasso*. They are the works of an artist who, even though he clothed the basic structure of his drama in a world of color and perspective that seems at times almost Shakespearean, arranges and groups and selects with an eye for the inner unity and harmony which characterizes the simplicity and repose and dignity of the Renaissance tradition.

In mentioning his return from Italy in 1788, where he had been particularly attracted to the many examples and masterpieces of Renaissance art, Goethe said: "Aus Italien, dem *formreichen*, war ich in das *gestaltlose* Deutschland zurückgewiesen." [9] In these words, it seems to me, he touches upon what had become for him the major problem of his life as artist and poet, and also upon the secret of the significance which the *Italian Journey* had for him. Possessing the instinct of the Renaissance artist, of the classicist, for a type of beauty and symmetry of form which characterizes a closed art-universe, he found himself born with a soul and spirit typically Germanic, and filled with a consciousness of restless and eternal longing and striving, and a sense of cosmic distance and direction. The content of Goethe's art works — of *Faust*, let us say — is Germanic, European, ba-

[9] Jubiläums-Ausgabe, 39 : 317; for Goethe's interest in Palladio in the *Italienische Reise* see *ibid.*, 26 : 55, 63, 77, 79 ff.

roque — indeed *Faust* has become a symbol of the ceaseless striving and effort of western civilization; but the basic tendency in form is classical and is of the Renaissance tradition. One is reminded, in this regard, of the statement of Oswald Spengler in *The Decline of the West*,[10] that, after all, the Renaissance was born of a spirit of protest — the artist's or humanist's defiance of a universe that seemed to be always just escaping his grasp, though he achieved, as Spengler says, something wonderful, namely, "a feeling for the bliss of perfect nearness, for pure, restful and liberating space-effects, bright and tidy and free from the passionate movement of Gothic and Baroque. It is not the classical, but it is a dream of classical existence, the only dream of the Faustian soul in which it was able to forget itself."

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[10] I: 238, 273 (Knopf, New York, 1926).

FRENCH COURTLY LOVE IN ENGLISH COMPOSITE ROMANCES

JOHN WILCOX

THIS paper is a continuation of a study published three years ago under the title "Defining Courtly Love."[1] At that time I presented an analysis of the ideas of love found in the literature patronized by Marie de Champagne in the latter part of the twelfth century. I am now applying the definition developed in that study to the English composite romances based on sophisticated courtly romances of French origin,[2] namely, *Ipomadon* and its two variants, *The Lyfe of Ipomydon* and *Ipomedon; Sir Degrevant; Generydes; Partonope of Blois;* and *The Squyr of Lowe Degre.* This present study has pertinence because it utilizes what is perhaps the best material in which to find the normal English reaction to the doctrines of Courtly Love. Writing late enough in the Middle Ages for the doctrines of Andreas Capellanus and the literary models of Chrétien de Troyes to be available influences, the authors of the composite romances should reflect the normal English reaction to these essentially French ideas of love better than translators, for they were free to accept or reject. Since these authors knew the Continental romantic literature from which they fabricated new combinations, we may be sure that they could not have been ignorant of French ideas, as the writers of original romances might. If the authors of English composites incorporated French ideas, it must have been because the ideas seemed acceptable to them and to their public; and, on the contrary, if they steadily rejected or modified certain ideas, there must have been determining differences in thought and taste between the two races.

[1] See note 3.

[2] Wells, J. E., *A Manual of the Writings in Middle English* (Yale University Press, New Haven, 1916), p. 141.

Before I take up the English romances, it may be useful to restate the definition of Courtly Love developed previously. After an analysis of the romances of Chrétien de Troyes and the treatise by Andreas, *De Arte Honeste Amandi*, I found that the conventions characteristic of the Courtly Love doctrines of Northern France were as follows:

A. *The worship of woman.* — The lover assumes the innate superiority of his mistress and gladly lives submissive to her will.

B. *Doctrinaire free love.* — The love is free in the sense that it is the spontaneous expression of mutual desire, unaffected by social, religious, or economic pressure. It is free in the sense that obligation ends with the death of desire. Like modern free love, it is a relationship of which the principals are proud. Only a hostile social order makes furtiveness an undesired practical necessity. It is unrelated to promiscuity or occasional laxness in conduct.

C. *Sublimation by chivalric activity.* — True love, under the courtly convention, always makes the lover a better knight. He transcends his old records for valor, fair play, generosity, humility, and courtesy. His energies are largely devoted to quests. Most of his service to his lady is done at such a distance that his love is largely sublimated.[3]

Let us now examine the English courtly composites in an order as nearly chronological as we can make it. The first one is *Ipomadon*, the best of the three extant Middle English versions of Hue de Rotelande's Anglo-Norman *Ipomédon*, which was written about 1190 by the Hertfordshire Norman who used various romantic materials, chiefly the motifs of the three days' tournament, the fair unknown, and the court fool.[4] These versions appeared in three different dialects in the fourteenth and fifteenth centuries. *Ipomadon* is a North Lancashire version of about 1350 and follows the original with fidelity.[5]

Ipomadon, the heir of the king and queen of Poyle (i.e. Apulia), has been carefully reared and trained in courtesy, hunting, and chivalry.[6] Hearing talk of La Fière, the beautiful young maiden

[3] Wilcox, John, "Defining Courtly Love," *Pap. Mich. Acad. Sci., Arts and Letters*, 12 (1930) : 322–323.

[4] Wells, *op. cit.*, p. 148.

[5] Hibbard, L. A., *Mediaeval Romance in England* (Oxford University Press, New York, 1924), p. 225.

[6] Kölbing, E., *Ipomedon in drei englischen Bearbeitungen* (Breslau, 1889) vv. 151–156. All later citations are to this text.

ruler of Calabrye, he longs to see her and learn the manners of her court. His tutor Talamewe gets the royal consent, and he and Ipomadon set out incognito. Ipomadon is received as a strange "valet" by the lady of Calabrye and made a cupbearer. He serves for three years with generosity, courtesy, and popularity. After a day of hunting in which he distinguishes himself before her eyes, the lady covertly betrays her love for him. Disguising her remarks by directing them at his friend Jason, she says:

> Yf thou wylte love of ladyes wynne,
> On othere wysse thou muste begynne;
> Syr, for thy good I saye!
> Gyff the to justes or to turnaynge,
> Or els lett be thy nyce lokynge,
> For helpe the not maye! [7]

When in bed she is unable to sleep from love of Ipomadon. She thinks regretfully of her oath never to wed anyone but the greatest knight in the world. She yearns for her unknown valet, and wonders how everything will come out. Ipomadon, too, lies sleepless and pale in his inn. Thus the symptoms prove both to be in love. That night Ipomadon resolves to go away and become the best knight in the world and then claim the lady.

He returns home to Poyle and after some years is victorious in every tournament throughout Christendom and Arabia. Meanwhile the lady of Calabrye is urged by her barons to choose a husband. When she demurs she is forced to appeal to the judgment of her uncle, King Mellyagere of Cessyle. They agree to call a tournament. Heralds are sent everywhere; the lady prays they will reach her lost "valet." Ipomadon hears the news, comes to the court of Mellyagere, and gets permission to act as the queen's courtly servant, asking no reward but a kiss. When the time for the tournament arrives he denies all interest and each day stays behind when the court goes forth to the tilting. Then he pretends to go hunting, but actually rushes secretly to the tournament and defeats all comers. He is the unknown knight, wearing, on three successive days, white, red, and black trappings in turn. Meanwhile faithful Talamewe does enough

[7] *Ibid.*, vv. 851–856.

hunting to provide the spoils of the chase that complete the deception. Each day the hero sends word to the lady, through his friend Jason, that the victory was won by her lover. Then he rushes back to the queen, feigning a day of hunting and receiving the jibes of all for his cowardice.

Instead of claiming the lady he has won, Ipomadon steals away from Mellyagere's court and hurries home to find his father dead. Still unwilling to settle down on the throne he sets out incognito, seeking further adventures and fighting everywhere. Sir Lyolyne, a repulsive but fierce knight, demands the hand of the lady of Calabrye and is ready to take it by force. She needs a champion. Shaved and dressed like a fool, Ipomadon turns up at Mellyagere's court and secures the boon of the next deed of arms. Soon a maid from Calabrye enters with the story of Sir Lyolyne's intentions. Naturally Ipomadon gets the mission and sets out with the maid, who has reluctantly accepted the fool to champion her lady. On the road he defends her from three knights who successively try to abduct her, the last one being the brother of Sir Lyolyne. Then the maid asks for Ipomadon's love, saying:

> Love will lett me have no peas:
> Syr, after my faders dysseace
> Off Burgayne ayre am I;
> Lett this alone and goo we theder,
> Ye shall be lord off all to geddyre,
> Both of bowre and bye! [8]

Thinking only of his one love, Ipomadon instantly dismisses the offer.

Dressed in black armor, Ipomadon appears before his beloved lady's castle and defeats the intrepid Sir Lyolyne, who treacherously takes advantage of Ipomadon's fatigue to circulate an untrue rumor of the fool's defeat, causing the lady to take to her ships. Misled by the black armor into thinking the victor is Lyolyne, a new figure, Cabanus, rushes from Mellyagere's court and fights Ipomadon. In the midst of the fight they recognize each other as brothers who had never met. A messenger hastens to the lady to identify the knight in the black armor:

[8] Kölbing, *op. cit.*, vv. 7203–7208.

He is the kyngis sone of Poyle,
He traveld hathe thorowe many a soyle,
For your love aventurs sought:
For your love he made kytte his here,
For your love he made him fole every where,
For your love grette wonder wrought,
For your love hathe sufferd payne,
And for your love Lyolyne hathe slayne,
And to the grounde hym brought.[9]

A huge wedding in the presence of the great was marked by the reward of retainers. The couple had several children and lived happy ever after.

The second version of the story, *The Lyfe of Ipomydon*,[10] an East Midland text written about 1400, condenses the story of Hue's 10,000 lines to fewer than 2,500. This version leaves out nearly every bit of the introspection on the part of the separated lovers which characterized the original; it contains the same action, but leaves it inadequately motivated. Not a word is given about Ipomydon's love for his lady except the first betraying gaze and a meeting just before the wedding. None of the other variations is pertinent. Courtly manners are more fully developed in *The Lyfe* than in the original.

The third redaction, *Ipomedon*,[11] found in a manuscript of the late fourteenth or early fifteenth century [12] tells, in prose of a badly mixed dialect, the same story as *Ipomadon*, keeping closer than *The Lyfe* to particulars of the plot, especially in the ruder conception of manners found in the early story. The details of the three days' fighting are much more elaborate than in *The Lyfe*, but the introspection of the lovers is just as carefully omitted.

In all three versions a certain worship of woman is implied, but not very consciously. It reaches the clearest expression in the last lines quoted above. Free love is absent. Chivalric sublimation during the courting period could not be more complete; it is the essence of the love story and the motivation of the adventures. The free use in *Ipomadon* of the old conventions of how people in love behave, some of which are as old as Sappho, sug-

[9] *Ibid.*, vv. 8669–8678.
[10] Edition cited in note 5.
[11] Edition cited in note 5.
[12] Wells, *op. cit.*, p. 147.

gests a familiarity with similar treatment in Chrétien or his courtly successors. Rules might be found in Andreas for many such incidents in this story. This would support the premise that the writers of composite romances knew the Continental literature of Courtly Love.

The next composite romance in the series, *Sir Degrevant*,[13] was composed in the North during the last half of the fourteenth century. Certain details of the story and of the stanza structure suggest that the unknown minstrel author had some contact with the Welsh,[14] although he wrote in good Northern dialect. Miss Hibbard thinks [15] it unlikely that there was an antecedent French romance, but there is much internal evidence that the author was familiar with the romances of the Continent. Since actual raids occurred before the earliest border ballad literature was written, the commonly admitted similarity of the opening to *The Hunting of the Cheviot* is not important. The composite character is shown by its unmistakable relation to the English romances *Eger and Grime* and *The Earle of Toulouse*.[15]

In the midst of a deadly quarrel with a neighboring earl over unfair hunting forays Sir Degrevant sees the earl's daughter Melidore and falls instantly in love. He has the usual symptoms, sadness, loss of appetite, sleeplessness, sighing, and weeping. At great peril to himself he visits her and avows his love. She declines his offers and sends him to sleep with her maid. He remains true by sending his squire to receive that favor. In a tournament Sir Degrevant wins a joust from the duke of Gerle, a suitor for Melidore's hand. The next day he again wins; both victories are due to the inspiration of Melidore's love.[16] The father is enraged, but such prowess wins the daughter's heart. She secretly receives him in her chamber and offers him a fine supper, which both enjoy in spite of the danger they know is involved. But when at midnight he asks her for the supreme gift

[13] Edited by Halliwell-Phillipps, J. O., in *Thornton Romances* (Camden Society, London, 1844), pp. 177–256.

[14] Brown, L., "On the Origin of Stanza Linking in Middle English Alliterative Verse," *Romanic Review*, 7 (1916) : 271–283.

[15] Hibbard, *op. cit.*, pp. 306–310.

[16] Edition cited in note 5, vv. 1289–1296.

of love, she quickly orders no more of that kind of talk until he marries her with her father's consent. He agrees to the terms, and then they sleep chastely in the same bed.[17] He passes nights with her under these conditions for nearly a year.

One night a forester follows him and his squire, and then hurries to her father with the scandalous news. The next night the earl's steward ambushes Sir Degrevant with a large force of men. The hero fights all night, slaying sixty assailants before the rest flee. The vengeful earl threatens Melidore, but her mother interferes and demands a peaceable settlement. Sir Degrevant is summoned, the quarrel ended, and a marriage concluded in a magnificent show of pomp and generosity. The couple inherit the earl's estate, live happily for thirty years, and have seven children. After Melidore dies the still vigorous Sir Degrevant goes to the Holy Land and makes a brave end fighting the sultan.

We find numerous conventional symptoms of love in *Sir Degrevant.* Although the hero is full of devotion and courteous consideration for his lady, the evidence of actual worship of woman is slight. Instead of free-love doctrine we have legal marriage after a chaste period of waiting for obstacles to disappear. Melidore's competence to guard her chastity and to turn her lover's desire into the way to matrimony, and their quaint custom of "bundling" emphasize the lady's virtue. As pointed out above, there is much sublimation of the knight's love into heroic action.

Let us turn to the third story on our list, *Generydes,*[18] which was composed in Midland dialect [19] about 1430 in two apparently independent versions. The shorter one (6,695 lines), found in the Trinity College manuscript, is used in this study. Schofield believes [20] that both were derived from a non-extant Anglo-

[17] Edition cited in note 5, vv. 1510–1544.

[18] Wright, W. A., *Generydes* (E. E. T. S., London, 1878).

[19] For this opinion as to dialect I have the unpublished judgment of Professor Charles C. Fries. Wright, Schofield, Wells, and Hibbard offer no comment on the dialect of the romance.

[20] Schofield, W. H., *English Literature from the Norman Conquest to Chaucer* (New York, 1906), p. 310.

Norman poem of the time and nature of *Ipomédon*. Miss Hibbard thinks [21] the original version, whether in French or in Middle English, was a fourteenth-century composite, made chiefly from French texts of current romances. Howe decided [22] in his study that the two manuscripts are entirely independent versions of the original. Echoes are heard of *Erec and Enide*, Marie's lay of *Guigemar*, and *Ipomédon*, Eastern legends much diluted, and other stock material of romances.

Two generations are represented in *Generydes*. The love story of Auferius, the father, is as follows: The wife of King Auferius of Inde is secretly unfaithful, loving the king's steward and eventually making him King Amelok. On a hunt a magic stag leads Auferius to Sereyne, princess of Surre (i.e. Syria); she tells him she is brought thither to bear him a son. They beget Generydes and part, each faithful to the love of the other. Years later the steward, abetted by the queen, creates a successful rebellion against Auferius, who flees to Thrace and starts life anew. Sereyne, who has never married, seeks him out. They are properly married; Auferius works up to the peaceful possession of the throne of Thrace; they have another son.

The story of the second generation starts when Generydes turns up at the court of Goffre, the Sowdon of Persia, and instantly becomes enamored of Goffre's daughter, Clarionas. They pledge their love and exchange rings early in the story, but encounter all sorts of delays before they are married.[23] Once their chaste relationship is slandered by an enemy of Generydes and her father

> . . . callid her, god wote, right shamefully
> All other wise thanne he cowde make the preff: . . .[24]

Generydes on one occasion fights before Clarionas, but she does not inspire unusual prowess.[25] Once Clarionas is abducted until Generydes rescues her. Later she is falsely told that he is forced to marry another; she believes it and swoons; on their next

[21] *Op. cit.*, p. 231.
[22] Hibbard, *op. cit.*, p. 232.
[23] The pledge comes at v. 906 and the marriage at v. 6911.
[24] Vv. 1452–1453.
[25] Vv. 2584–2786.

meeting he upbraids her and then forgives her lack of faith.[26] They spend that night together in chaste embraces,

> Nor sownyng to [no] villany ne shame
> In grete pleasure and in all goodlihede.[27]

Disheartened by the death of many relatives, Generydes falls sick at Damas. Clarionas comes and cures him by her loving care. They soon marry, inherit the kingdoms of Persia, India, and Thrace, and are last seen arranging marriages for their issue.

In *Generydes* we find almost none of the conventional symptoms of love except sadness and swooning. Romantic love leading to marriage through innumerable obstacles, including parental opposition, is the way of life. Auferius and Sereyne acquiesce in this doctrine by legalizing their love as soon as possible. There is no worship of woman, as the upbraiding of Clarionas shows clearly. Chivalric sublimation is entirely ignored; Generydes battles bravely because he is a strong, courageous knight, but his valor has no relation to his love for Clarionas.

Our fourth romance, *Partonope of Blois*,[28] exists in two fifteenth-century versions that vary considerably in substance and form. The longer is in the Southern dialect; it was based on the extant French *Partonopeus de Blois*, of which there are several versions. The shorter seems to have come from a lost subsidiary French text.[29] We are dealing, then, not with an English composite, but with English versions of a French composite. In a brief discussion of the sources Schofield [30] mentions *Cupid and Psyche*, *Yvain*, the fair unknown, and the Breton lays of *Guingamor*, *Guigemar*, and *Lanval*.

Lost on a hunt young Partonope comes to a ship and enters. It sails magically away to an enchanted country where he finds a castle and hospitality proffered by invisible hands. In his bed in the dark he discovers a charming companion, with whom he experiences the *Cupid and Psyche* story over again. The lady, Melior, tells him she is queen of Byzantium and has used these enchant-

[26] Vv. 6314–6323. [27] Vv. 6339–6340.

[28] Bödker, A. T., *The Middle-English Versions of Partonope of Blois* (E. E. T. S., London, 1912).

[29] Hibbard, *op. cit.*, pp. 200–213. [30] *Op. cit.*, pp. 307–308.

ments to bring him to her as a lover. He pledges faithfulness; she says she must stay invisible for a year and a half, and then they may be married. Meanwhile they may enjoy each other fully. This is the only one of the composites that gives much space to detailing the intimacies and felicities of lovers.[31] In exchanging lovers' vows they restate the essence of the courtly code, particularly the expression of love in great deeds of valor. He is obedient and shows a courtly inclination to worship her will blindly. His later troubles come from his failure to keep his love secret, a *fée motif* rationalized under the second rule of Andreas.

When twelve months have passed, Partonope proposes to visit his uncle, the king of France, and his mother. Melior tells him that his father is dead, the country invaded, and his presence needed. After 2,500 lines of military exploits that consume Partonope's energies, the wars are over; he thinks again of Melior and of his promise to return to her. His mother induces him to reveal his love story to her. She and the king of France plot to keep him at home by means of a love potion and a pretty niece of the king. Just as he embraces the new love under the influence of the drug, she speaks of his old love, his senses suddenly return, and he bolts. He revisits Melior, confesses, and hears her understanding forgiveness as she says:

> I love you a thowsande fold þe more,
> That ye have been asayde so sore,
> And leve hem alle and drawe to me.[32]

In a fortnight Partonope again goes home after further pledges and warnings against his mother's plots. His mother has the bishop of Paris convict him of his sins. Under this new influence he returns to Melior with an enchanted lantern; he sees his invisible lady, and the débâcle of the broken spell follows. Both lovers swoon; then they sadly part. Retiring to Blois, Partonope refuses to see his mother or the bishop and quickly degenerates into the semblance of an old man. A year of this is enough; he goes to the Ardennes to be killed by wild beasts. There Melior's

[31] Edition cited in note 28, vv. 1179–1591.
[32] *Ibid.*, vv. 5476–5478.

sister Urake finds him, cheers him with forged letters from Melior, and tends him until he recovers his youth and strength. Partonope will not allow Urake to blame Melior for cruelty.

> "Why," seide he, "I did her treasone,
> Wherefore I have deserved wele
> Ever to lyve in care and dole,
> Till that hir lust to foryeve me
> For as she will so mote it be." [33]

When a young woman accompanying Urake falls in love with Partonope, his constancy to Melior is incredible to the English poet who interrupts to say:

> Thus seith myn auctours after whome I write,
> Blame not me: I most endite
> As nye after hym as ever I may,
> Be it soþe or less I can not say.[34]

Urake visits Melior, who has lost her enchanted nature, to prepare her to receive Partonope, telling her how he has suffered but keeping his recent recovery a secret. As Melior's barons are demanding her marriage and insisting that she choose a brave man, a tournament is proclaimed for that purpose. Melior fears she has lost her Partonope and knows she can love no other. Urake prepares Partonope for the tilting. While Melior suffers from disappointed love, Urake teases her mercilessly; but she smuggles Partonope into the palace, so that Melior unwittingly knights him with a hundred others, as she had once said she should do. Before the tournament the poet interrupts his story to bewail the present coldness of women. Whereas men used to win ladies by prowess, riches, largesse, fair speech, and the like, now

> The worlde is turned anoþer way.
> For neyther richesse ne beaute
> Ne fayre speche in no degre
> May make a man his love to wynne
> They be so sore a-ferde to synne: . . .[35]

Thus the moral changes brought to England by the religious zeal associated with Wyclif and the Lollards sadden the poet. In

[33] *Ibid.*, vv. 7511–7515.
[34] *Ibid.*, vv. 7742–7745.
[35] *Ibid.*, vv. 9671–9675.

the tournament Partonope is recognized by Melior. All the combatants fight like lions because she watches them, but Partonope and a friend are among the best. After the fighting the poet maintains the suspense for hundreds of lines as obstacle after obstacle arises and disappears, but Partonope and Melior are finally married and left very happy on the wedding day.

Partonope of Blois is the only one of the composites to permit extreme intimacy between hero and heroine before marriage and to imply the essential goodness of the relationship. (Auferius is hardly the hero in *Generydes*.) Being closer to the French than the others, this emphasizes the English reluctance to sanction free love. Little stress is placed on love as a source of strength, although the idea lingers in the story, suggesting that the English poet did not fully grasp the significance of sublimation as a part of love doctrine. An attitude of obedience to Melior runs through Partonope's career and helps compose the plot.

The last romance on the list, *The Squyr of Lowe Degre*,[36] is a short fifteenth-century composite from East Midland. A squire of low rank in the service of the king of Hungary loves the princess, who rewards his overheard sighs with the promise of her love. He must qualify, however, by seven years' apprenticeship to chivalry and then win her father's consent. But a rival spies on his wooing and, with the king's permission, assails the squire when he returns to his lady's chamber to bid farewell. In the fight the squire kills the rival and escapes after exchanging clothes with his victim. The lady embalms her supposed lover's mutilated head and keeps it by her bed. After seven years' exile the squire returns in time to get the father's consent, the girl's hand, and the kingdom. There is little originality in the story, for almost every shred and patch has a thread traced to other romances. The two extant versions seem to have been formed from a common antecedent tale of English origin and of the same general substance.[37] This, the last of the series, follows closely the English ideas of love. Chivalric activity is not a sublimation, but, as often elsewhere, is a rationalization of the doctrine

[36] Mead, W. E., *The Squyr of Lowe Degre* (Ginn and Co., Boston, 1904).
[37] Hibbard, *op. cit.*, p. 263.

of sublimation. The heroic events are performed to secure parental consent and to remove material obstacles to a successful married life, not to express love in another way. There is some emphasis on the worship of woman, but not a concession of her innate perfection. Rather the idea of perfection is rationalized as proof of the intensity of the lover's desire, and made natural by her social superiority. Romantic love leading to marriage has its customary place. Unquestioned social convention produces the usual premarital restraint.

> That my father so fayne may be,
> That he wyll wede me unto thee,
> . . . . . .
> That we might our dayes endure
> In parfayte love that is so pure.[38]

After this survey of the English composite romances we may consolidate the characteristics common to them and transfer these characteristics to the English people with some confidence that they are descriptive. First, let us consider the significance of their geographical distribution. The North, North Lancashire, Midland, East Midland, and Southern dialects are represented. Characteristics common to these romances may be reasonably extended to the greater part of the island, for the West is the only considerable region not represented. Our conclusions should apply to both the Anglo-Norman and the Saxon elements of the population, but not to the Celtic. In short, we have a fair survey of some opinions prevailing throughout England from 1350 to 1500 about the proper relation between the sexes, opinions that are more precisely stated because they are a conscious reaction to French doctrines of Courtly Love.

In none of these English stories does the doctrine of worship of woman appear well developed and clearly announced; something like social equality is assumed. Where considerable deference appears, as in *Partonope of Blois*, it is obviously closer to the French source, a Southern text on a French original. The tendency to place woman on a pedestal, which has been more characteristic of English-speaking people than any others, may have

[38] Mead, *op. cit.*, vv. 259–266.

been inherent in early Germanic culture, or it may have entered English life through some influence such as that of Petrarch on sixteenth-century England, but it did not grow directly out of the doctrines of Courtly Love.

Romantic love leading to marriage, and chaste awaiting the formal marriage rite are the perennial English substitutes for doctrinaire free love. Instead of despairing of happiness in legal marriage, as the French romancers did, the English assumed that they lived happy ever after, if the union came from a strong premarital attraction. Free choice before marriage was a sufficiently smooth road to happiness. Parental consent was a difficult but not insurmountable obstacle, in the English opinion. The two exceptions to these principles, Auferius' love for Sereyne [39] and Partonope's love for Melior, go scarcely halfway in the direction of free love, for in each case the lovers legitimatize their relationship by the marriage ceremony as soon as external barriers are removed, and so cease to be protagonists of an unconventional way of life. Even this hasty method of making "an honest woman" was contrary to English law. Medley says of the late Middle Ages:

> A laudable desire to protect the sacredness of family life produced the tables of degrees of affinity within which marriage was forbidden by the Church; but the dispensations freely granted by the Pope to kings and nobles for all kinds of uncanonical unions seemed to teach subsequent generations that the law of social convenience was of more importance than the maintenance of an inflexible moral standard. It was in keeping with these views that while unlicensed marriage within the prohibited degrees was regarded as incestuous intercourse, the cohabitation of unrelated persons came in time to be atoned for by subsequent marriage, and their children born out of wedlock were then regarded as legitimate. *England was the only country of Western Christendom where the legislators refused to accept this relaxation of the earlier reading of the law.*[40]

Although some might see a relation between the sublimation found in Courtly Love and the nineteenth-century doctrine of the redemption of a man through the love of a pure woman, there is no clearly established continuity through the composite romances. Ipomadon, Sir Degrevant, Partonope, and the Squire of

[39] In *Generydes*.

[40] Medley, D. J., in *Social England*, edited by H. D. Traill and J. S. Mann (Cassell & Company, Ltd., London, 1903), II: 776 (italics are mine).

Low Degree do valorous deeds to gain the love of the lady, but it seems to be just a method of establishing social prestige and of breaking down parental objection thereby. The insight into human nature that lies behind the Courtly exaggeration of the doctrine of sublimation is wholly lacking. English notions of love were so strictly devoted to the single end of legal mating that the authors thought of the consequence in terms of progeny rather than in terms of human felicity. *The Squyr of Lowe Degre* and *Partonope of Blois* are the only composites that do not close with a brief account of the offspring of the union. Any hint of the doctrine of sublimation was confined to the period of rigid continence preceding marriage; here the narrators often seem to rationalize French material into a conventional respect for the chastity expected by society.

Although it has no relation to the doctrines of Courtly Love, the attitude of the composites toward the details of the intimacies of lovers has been interesting to note. Like the sophisticated analysis of motives and emotions, these details seem to have been deliberately skimped. Intimacy outside wedlock was folly for the woman and sin for both. Intimacy within wedlock was nothing to talk about. The early Christian doctrine that the sexual relation is in itself indecent seems to have persisted more strongly in England than in Catholic France. Even the author of the half-French *Partonope,* who gives several hundred lines to an intimate description of the first union of the hero and Melior, refuses to go into details again after the wedding. At first he thinks he will, saying as he describes the close of the wedding day,

> But lete us tell, when the feste do,
> How thes hote lovers to chamber go.

Then he immediately retreats from his own promise with the timid words, "But this may not be declared for me." [41] The narrative ends after only eight lines more. Is this anything but prudery?

Our conclusion, far from radical in nature, merely asserts over again that certain social patterns in England seem to be the

[41] *Op. cit.*, vv. 12182 to end.

product of a national temper that has persisted for centuries. Sexual asceticism, for example, seems to go back as far as the fourteenth century and cannot be credited to seventeenth-century Puritanism. Something like "Victorian morality and prudery," as defined by a contemporary Georgian, had a place in the English temper as early as 1350 at least, and these do not necessarily date from a reaction to the excesses of the Regency. The contrast between nineteenth-century France and England is just as old. By 1170 Marie de Champagne had declared love in marriage impossible, because the gifts of love must be free and could not come as a marital duty. Whether the English assumption that a strong premarital inclination is an adequate guarantee of matrimonial joy is based on English experience, or whether the nation has stubbornly persisted for six or seven centuries in a vain optimism, is beyond the province of this study.

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A METHOD FOR APPROXIMATING REAL ROOTS OF EQUATIONS BY THE PRINCIPLE OF AREAS

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SO FAR as the writer is aware, the following method for approximating real roots of equations is new. It depends upon the principle that the number of square units in the area under the derived curve between any two ordinates is equal to the

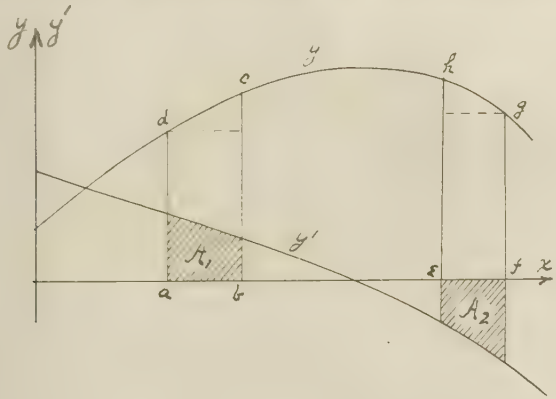

FIGURE 26

number of linear units in the difference between the corresponding ordinates on the integral curve. The ordinate at the left must be subtracted from the ordinate at the right. The principle is illustrated in Figure 26: $A_1 = bc - ad$, and $A_2 = fg - eh$.

In order to approximate a root of an equation $y = f(x) = 0$ by this method it is necessary to start with three corresponding values of x and y, the three values of x being so chosen that the

root lies between two of them. Figure 27 shows the relation between the area under the derived curve and the root of the equation. The three chosen values of x and y locate the three points $a(x_a, y_a)$, $b(x_b, y_b)$, and $c(x_c, y_c)$. It is evident that the shaded area which extends from $x = x_b$ to $x = x_o$ (x_o being the root which lies between x_b and x_c) must be equal numerically to the ordinate of the point b. But, in general, this area cannot be found exactly. The following approximation is quite short.

Consider the parabola, y, through the three points a, b, and c, having its axis parallel to the y-axis. Its derivative, y', and its

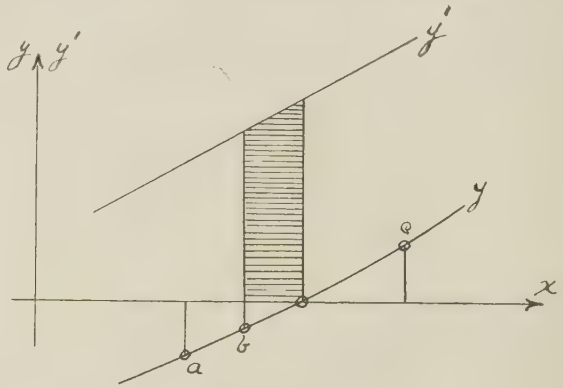

FIGURE 27

intersection with the x-axis are easily found without knowing the equation of the parabola. The intersection of the parabola with the x-axis gives a close approximation to the root, provided the three points are close together.

Figure 28 shows how to differentiate the parabola through the three points a, b, and c. The area of the first rectangle is $\Delta y_a = y_b - y_a$, the area of the second rectangle is $\Delta y_b = y_c - y_b$. By the principle of areas the derivative will be the straight line passing through the mid-points, P and Q, of the upper boundaries of the rectangles.

In order to find an approximate value of the root it is necessary

to find only the width of the trapezoid whose area is equal to $-y_b$ (the area is equal to $0 - y_b$) and add this width to x_b. The upper boundary of this trapezoid is the derivative of the parabola passing through the three chosen points. The boundary at the left is y'_b. By repeating this process the root can be found to any degree of approximation, as examples will show.

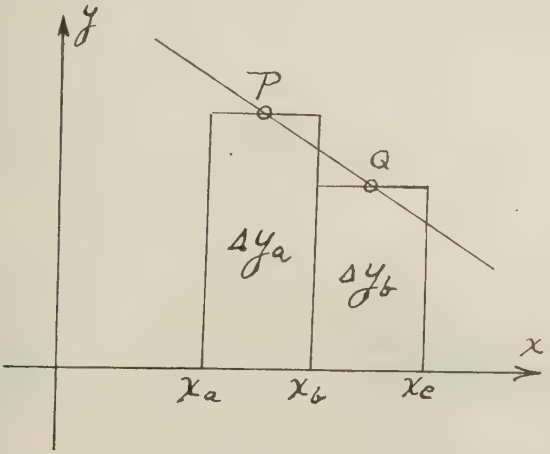

FIGURE 28

Example 1. — Find the root of $y = e^{-x} + \frac{1}{2}\sin x - x = 0$. By a rough graph it is seen that the root lies between .7 and .9. The second column of Table I gives values of y corresponding to the three chosen values x in the neighborhood of the root. The third column gives the values of $\Delta y/\Delta x$ which locate the upper boundaries of the rectangles mentioned above. The equation of the line passing through the mid-points of these upper boundaries is the derivative of the parabola through the three points and written at the right.

TABLE I

x	y	$\Delta y/\Delta x$	
.7	.1187		
		− 1.107	
.8	.0080		$y' = .1\,x - 1.182$
		− 1.097	
.9	− .1017		

TABLE II

x	y'	Areas
.8	− 1.102	− .0080
.807	− 1.1013	− .00029
.8073		

Table II gives the process of the first approximation. From Table I it is seen that the root lies between .8 and .9. In the second column are given values of y' corresponding to values of x. The total area of the trapezoid is − .0080 (negative of the value of y corresponding to $x = .8$). Dividing − .0080 by the first value of y' gives .007, which is added to .8. The area of the trapezoid, whose parallel sides are the two values of y' and whose width is .007, is subtracted from − .0080, leaving − .00029. The next digit in the root is obtained by dividing − .00029 by − 1.1013. The last digit in .8073 is doubtful. We feel quite confident, however, that the root is closed to .807.

To obtain a better value repeat the process, using a seven-place table. Tables III and IV are obtained in exactly the same way as Tables I and II were obtained.

TABLE III

x	y	$\Delta y/\Delta x$	
.806	.0014028		
		− 1.1004	
.807	.0003024		$y' = -.1\,x - 1.01975$
		− 1.1005	
.808	− .0007981		

TABLE IV

x	y'	Areas
.807	− 1.10045	− .0003024
.807274	− 1.1004774	− .00000087
.8072748		

The last value, .8072748, may be in error a unit in the last place. Had a ten-place table been used, the value of x would have been obtained correct to at least eight places.

Example 2. — Find the real root of $y = x^7 - 3x^4 - 6 = 0$. A rough graph of the equation shows that the root lies between 1.5 and 1.7. The tables below indicate the process of solution.

x	y	$\Delta y/\Delta x$	
1.5	− 4.1016	52.844	
1.6	+ 1.1828	87.952	$y' = 351.08\,x - 491.33.$
1.7	+ 9.9780		

x	y'	Areas
1.5	35.29	4.1016
1.58	63.3764	0.154944
1.582		

The root is in the neighborhood of 1.582.

x	y	$\Delta y/\Delta x$	
1.581	− .05330		
		62.06	
1.582	.00876		$y' = 310\,x - 428.205$
		62.37	
1.583	.07113		

x	y'	Areas
1.581	61.905	.05330
1.5818	62.153	.0036768
1.58185	62.1685	.00056876
1.581859	62.17129	.00000923
1.58185915		

The eighth place is in error.

The process may easily be applied to the solution of two simultaneous equations in two unknowns.

The separation of roots that are very nearly equal is illustrated in the next example.

Example 3. — Find the roots of $e^{-3x} + x - .69955 = 0$.

It is easily seen by use of either a graph or a slide rule that the roots if any must lie between .36 and .38.

x	y	$\Delta y/\Delta x$	
.36	.0000455		
		− .00365	
.37	.0000090		$y' = 2.965\,x - 1.085875.$
		.02600	
.38	.0002690		$(y' = 0) \quad x = .3662.$

x	y'	Areas	
.36	− .018475	− .0000455	.3662
			.3633
.363	− .009580	− .0000034175	.0029
			.3662
.3633			.3691

The computation at the right shows how to obtain the second root. The two roots are located symmetrically with respect to the critical value of x (.3662).

The roots are, to four places, .3633 and .3691. To obtain better values the approximations must be carried out separately.

FIRST ROOT

x	y	$\Delta y/\Delta x$	
.362	.0000141		
		− .0112	
.363	.0000029		$y' = 3\,x - 1.0987$
		− .0082	
.364	− .0000053		

x	y'	Areas
.363	− .0097	− .0000029
.3633	− .0088	− .000000125
.36331	− .00877	− .00000003715
.363314		

SECOND ROOT

x	y	$\Delta y/\Delta x$	
.368	− .0000077		
		.0068	
.369	− .0000009		$y' = 3.1\,x - 1.13555.$
		.0099	
.370	.0000090		

x	y'	Areas
.369	.00835	.0000009
.3691	.00866	.00000005
.369106		

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CONSTANCY OF MEASURES OF DIFFICULTY OVER A PERIOD OF TIME IN THE FIELD OF SPELLING

WENDELL VREELAND

THE idea that a given word has among its characteristics a certain inherent difficulty which is constant from grade to grade, from place to place, and from time to time, is not new. Approximately twenty years ago, Buckingham, in discussing his preparation of a new list of words for the measurement of spelling ability, wrote: "In order that this list should be of greatest value it should be so constituted that these increases in 'per-cents-correct' so keep pace with the increase from grade to grade of general spelling ability that a word tends in all grades to maintain the same difficulty relative to all other words in the list to which it belongs. A word which is twentieth in point of difficulty for the third grade ought to deviate as little as possible from the same rank in the other grades." [1]

Many people who have worked in the field of spelling agree with this general theory. The idea is one which has found wide acceptance. On the other hand, experience has shown it very difficult to prove that the theory is supported by fact. Anyone who has ever used more than a single source of information as a means to the standardization of a spelling test or as a basis for the interpretation of the results of a spelling survey, will readily agree with Buckingham when he adds: "The experience gained in making this investigation leads us to think that most words do not meet this condition even approximately." [2] Words

[1] Buckingham, B. R., *Spelling Ability — Its Measurement and Distribution*, p. 13. Contributions to Education, No. 59. New York, Teachers College, Columbia University, 1913. [2] *Ibid.*

simply do not maintain the same rank order of difficulty from one grade to another in any consistent fashion.

What is true of comparisons between words is also true of comparisons of the difficulty of the same word as determined by different investigators under different conditions. If we take almost any word and turn to the reports made by such men as

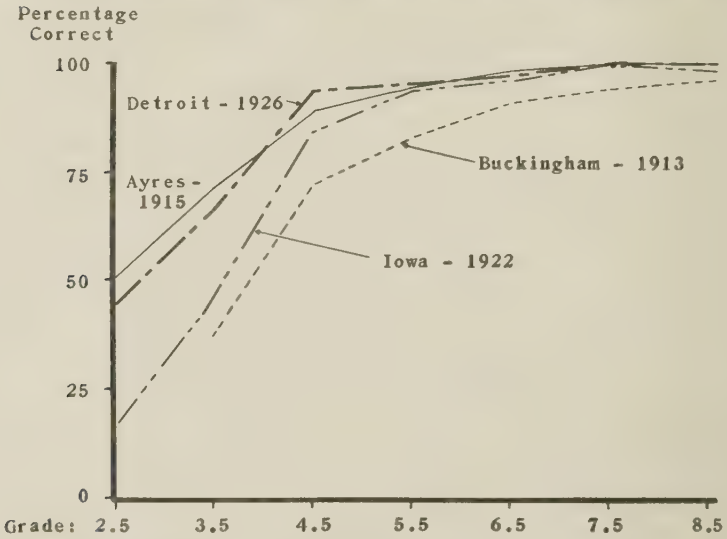

FIG. 29. Difficulty of spelling the word "lesson" as reported in four independent surveys

Percentage of pupils in total-grade groups who spelled "lesson" correctly

Buckingham, Ayres, Ashbaugh, and Horn, we shall find just such variation and such discrepancies in the reported measures of its difficulty as occur, for instance, with the word "lesson" (Fig. 29). Buckingham's spelling list of 1913 shows this word to be more difficult than do the Iowa Spelling Scales and the Ayres scale, and both of these indicate the word to be of greater difficulty at many points than did the Detroit spelling survey of 1926. When variations in measures of difficulty on a single

word are as pronounced as they are here — and this is an instance where variation is far less than is found with many words which are included in the several surveys — grave questions must arise as to the validity of the very concept of constant intrinsic difficulty.

Of course, explanations for such baffling irregularities are not hard to find. Critics hasten to point out that the children used in the various surveys lived in different localities; they had no doubt received instruction of differing intensity and merit; they had studied under differing courses of study. In other words, these critics tell us that, with conditions so little approximating standardization, constancy in measures of difficulty should not be expected. They point out that the law of the single variable is not even approached. They insist that when the *same children* are taught the *same words* under *uniform conditions* with some *standard form and intensity of instruction*, then, and then only, may we hope to find constancy in measures of the intrinsic difficulty of spelling particular words.

Recently there have become available data which much more nearly approach these conditions than did data which were available in the past. In June of 1931 a spelling survey conducted in the Detroit Public Schools in Grades 2B to 12B inclusive used the words of the Detroit Spelling Scale which had been developed for, and used in connection with, the survey of January, 1926. In 1926 and again in 1931 a very considerable number of students' papers were collected to form the basis of a study of the difficulty of individual words. Precautions were taken in the selection of the papers to insure that the sampling was representative for Detroit. Also, care was exercised that the distribution of intelligence quotients among the pupils should be that of the entire school population. Nationalities and home languages in the selected group paralleled those of the entire group. Further, the course of study in Detroit had remained practically unchanged, and the methods of instruction in this field had been altered little, if any, during the five-year interval. It would appear that in these data many of the factors are constant, or nearly so, which in earlier surveys obviously were quite uncontrolled. Here it would seem possible to test afresh the hypothesis of con-

stancy in measures of intrinsic difficulty and to secure objective evidence on a point which has been long in question.

The present paper reports the first findings of a comparison of the measures of difficulty secured in 1931 and in 1926. After a brief review of the characteristics of the test, it will array: (1) the distribution of the fifty words according to their difficulty as expressed in four different measures; (2) further and independent evidence on the question of whether conditions have been truly

Second Hand				
60	1.	at	Jack is at home.	at
20	2.	book	My book is new.	book
40	3.	she	She broke her pencil.	she
60	4.	that	This is the pen that was lost.	that
40	30.	material .	She bought the material for a new dress.	mate′rial
60	40.	executive	The governor is a state executive.	exec′utive
20	50.	guarantee	The watch has a twenty year guarantee.	guar′antee′

FIG. 30. Portion of the Detroit Spelling Scale

Selection from the scale illustrating its organization to facilitate accurate timing, to insure the use of identical illustrative sentences, and to standardize pronunciation.

constant; (3) the effects of adjustments attempted to allow for known changes in conditions; and (4) a brief, admittedly subjective appraisal of the modes of expression here employed.

The Detroit Spelling Scale (Fig. 30), which was used in the surveys of 1926 and 1931, consists of fifty words, all of which are to be found in the Iowa Spelling Scales.[3] All the words were also

[3] Ashbaugh, Ernest J., *The Iowa Spelling Scales — Their Derivation, Uses, and Limitations.* Journal of Educational Research Monographs, No. 3. Bloomington, Ill., Public School Publishing Co., 1922.

in either the Buckingham revision of the Ayres scale [4] or the so-called "Seven-S" scales.[5] They were arranged in the order of their difficulty, from easy to hard, in terms of percentages of correct spelling in the Iowa scale for Grade V. The test was so constructed that the examiner dictated the number of the word, pronounced the word, read a sentence with the word in it, and pronounced the word again. Twenty seconds were allowed from the time the number of one word was given until the number of the next word was given. Examiners were asked to equip themselves with watches with second hands in order to assure uniform timing, and were instructed to use a standardized pronunciation. When the tests had been given they were scored in the schools either by the pupils themselves under the examiners' direction or, in the cases of pupils too young to do the work themselves, by pupils in the upper grades. Though the surveys involved many thousands of pupils, individual test papers were gathered from a sampling of only approximately 10,000 pupils in each of the two surveys. It is upon the analysis of the spelling of individual words in these papers that the present report is built.

Measurement of relative spelling difficulty may be expressed in any one of many different ways. Four are used here. Of these, the first pair, "percentage correct" and "sigma difficulty," are closely associated. The second pair, "spelling complexity" measured on two different bases, are also alike in most details.

From the time of the earliest studies in the field of spelling the percentage of a grade group succeeding in spelling a given word has been a common measure of the relative difficulty of the word. Another measure which has been very frequently used is the "sigma position" of a word as determined from the percentage of correct spellings in a single grade group, with the assistance of the theory of the normal curve.[6] The comparison of spelling

[4] *Buckingham Extension of the Ayres Spelling Scale.* Bloomington, Ill., Public School Publishing Co.

[5] *Sixteen Spelling Scales Standardized in Sentences for Secondary Schools.* Prepared under the direction of Thomas H. Briggs and Truman L. Kelley. New York, Teachers College, Columbia University.

[6] The use of "sigma position," or its correlative, "P. E. difficulty," has been prominent in a number of well-known studies: for instance, in those of

difficulty from grade group to grade group on the basis of either of these measures has been found peculiarly erratic and singularly confusing. If, as in the present instance, the same words are measured in a wide range of grades, troublesome zero-per-cent and one-hundred-per-cent words are frequently found in the grades toward the extremes of the range. The data most generally employed in making comparisons of the sort attempted in this paper are taken from one of the middle grades. Wherever a spelling test is composed of words approximately as difficult as those in the Detroit Spelling Scale, such a grade is unquestionably the optimum point for measurement with these devices.

More recently there has been developed for measuring intrinsic difficulty [7] a technique which summarizes the performance of pupils not merely in a single group, but rather in a wide range of groups. The technique is built upon the use of the Gompertz curve as an instrument for the summarization of growth in such a specific ability as learning to spell a word, and eventuates in a measure of difficulty which is styled "spelling complexity." This measure yields exactly the same type of result with words which are mastered only after the highest grades have been reached, with words which are mastered before the lowest grades are passed, and with words which fall between these extremes. In this report "spelling complexity" is used to measure difficulty in two types of situations which are distinguished by the groups upon whose achievement the development curve is based. In the first, pupils who are found in in-grade-at-age [8] groups are used; in the second, pupils of total-age groups. The two bases yield significantly different results although the basic measure, spelling complexity, is derived in the same manner in the two situations.

Ashbaugh, Ernest J., *op. cit.*; Ayres, Leonard P., *A Measuring Scale for Ability in Spelling* (New York, Russell Sage Foundation, 1915); Buckingham, B. R., *op. cit.*

[7] Courtis, Stuart A., "Maturation Units for the Measurement of Growth," *School and Society*, 30 (1929) : 683–690; *idem*, "Factors Conditioning Growth," *Pap. Mich. Acad. Sci., Arts and Letters*, 10 (1928) : 349–367.

[8] By "in-grade-at-age" groups are meant those children in a given grade whose age is the age normally expected there. For instance, children who are 7.5 years old in Grade 2B, 8.5 years old in 3B, 9.5 years old in 4B, and so on, constitute the in-grade-at-age groups in this study.

To summarize, the modes of expression of spelling difficulty whose constancy between the Detroit surveys of 1926 and 1931 is investigated in this study are:

1. Percentage of correct spelling (Grade 5B);
2. Sigma position (Grade 5B);
3. Spelling complexity, based on pupils in-grade-at-age (Grade 2B, age 7.5 through Grade 12B, age 17.5);
4. Spelling complexity, based on pupils in total-age groups (ages 6–14).

The distribution of the fifty words according to percentage of correct spelling in each of the two surveys is unusual in that it is U-shaped (Table I). There are exceptionally large frequencies at both extremes of the scale. Significant changes are to be found in the five years, however. Whereas in 1926 fourteen words were so easy that between 80 and 100 per cent of the children in Grade 5B spelled them correctly, there apparently were but eleven words as easy in 1931. At the other end of the scale, the most difficult words have been increased from twenty-one to twenty-five. Measures of central tendency reflect the general increase in the relative difficulty of the words in the spelling scale.

TABLE I

Distribution of Words according to Difficulty as Measured by Percentage of Correct Spelling (Grade 5B)

Percentage correct	1926	1931
0–9	16	17
10–19	5	8
20–29	5	3
30–39	3	2
40–49	2	3
50–59	3	1
60–69	0	2
70 79	2	3
80 89	4	1
90–99	10	10
Total	50	50
Mean	41.5	37.9
Median	28.0	20.0

The distribution of words according to sigma position (Table II) is of a form different from that of percentage of correct spelling,

although the sigma position of a word is based directly upon the percentage of correct spelling for that word in the same half-grade. Here, too, the measures of central tendency indicate an apparent increase in relative difficulty over the five-year interval.

Before the corresponding distributions of the fifty words according to spelling complexity are presented, a brief explanation of the concept may well be inserted. As was indicated earlier, the measure, spelling complexity, is based upon performance of children in a wide range either of grades or of ages.[9] It is, in fact, directly related to the rate at which children in successive grades or of successive ages master the spelling of a given word. Stated somewhat differently, complexity is measured by the time which needs to elapse for a given group of children, living under uniform conditions of training, to develop from the state in which none is able to spell the word to the one in which all can spell the word. The shorter the time, the less the complexity; the longer the time, the greater the complexity.

TABLE II

Distribution of Words according to Difficulty as Measured by Sigma Position (Grade 5B)

Sigma position	1926	1931
5.00–5.49	..	3
4.50–4.99	5	6
4.00–4.49	7	6
3.50–3.99	5	8
3.00–3.49	9	4
2.50–2.99	5	6
2.00–2.49	3	3
1.50–1.99	5	4
1.00–1.49	4	1
.50 - .99	6	3
.00 - .49	1	6
Total	50	50
Mean	2.81	2.95
Median	3.06	3.25

[9] The reason for using children in a range of grades or of ages as a basis for development curves is found in the assumption that the performance of successive groups yields the best present approximation of the development

Looked at from still another angle, this means that the complexity of a word is inversely proportional to the *slope* of the curve fitted to data representing the percentage of children in the successive groups spelling the word correctly. The steeper the curve of a word as it rises from 0 toward 100 per cent correct, the easier the word or the less its complexity. Curve 1 (Fig. 31) thus reflects less complexity than do curves 2, 3, 5, and 7; curve 2, less than do curves 3, 5, and 7; and so on. Curve 7 represents the most complex word of those whose curves are arrayed here.

Complexity, as it is here defined, must be differentiated carefully from the "time-placement" of a word. Though it is unquestionably true that both the rate at which a word is mastered and the time at which children normally begin to acquire it need to be considered in any ultimate, practical measure of the difficulty of spelling a word, nevertheless the measure of complexity used in this study is related only to the rate at which mastery develops. The distinction can perhaps be made most clear by contrasting the curves in Figure 31 with those in Figure 32. In the second of these figures practically the only difference between the words represented is a difference in time-placement; in the first, practically the only difference is one of complexity.

Complexity makes it possible not only to say that one word is intrinsically more difficult than another, but also to report how many times more difficult the one is than the other. For instance, if "hot" (complexity, 7.3) be taken as a unit, "sugar" (14.5) is twice as complex; "telegram" (34.1) is five times as complex; and so on. This suggests two possibilities in the standardization of the spelling difficulties of words: (1) the complexity of some one word may be taken as a unit, or (2) a theoretical, standard unit may be defined for use with all words. In the present study the latter course is the one which has been followed. The definition of "unit complexity" which obtains throughout

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curve which would be generated by the performance of a given group of children if it were possible to measure them again and again at similarly spaced intervals of time. The striking similarity of pattern found in most of the development curves for words in the 1926 and 1931 Detroit surveys (see Figs. 33 34) constitutes supporting evidence on the point.

is as follows: "A word of unit complexity is one which, under standard conditions of training and for a normal distribution of nature elements, matures in one unit of time." The unit of time here used is the grade or year.

Courtis' procedure in fitting the Gompertz curve through its reduction to a straight line by means of "isochrons" opens the

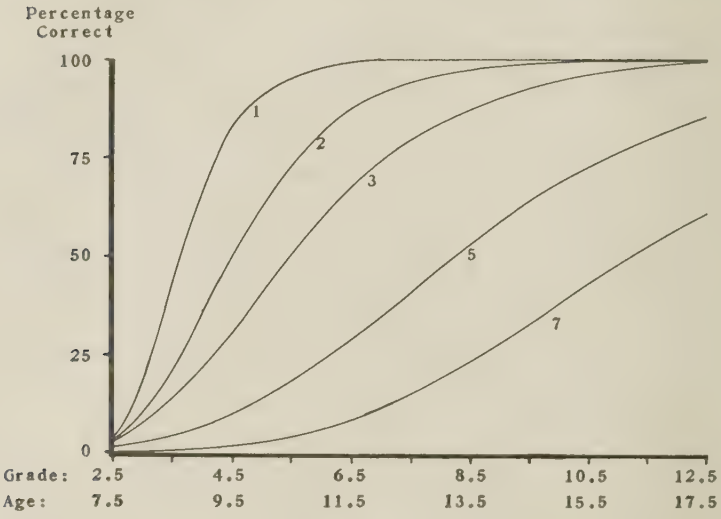

FIG. 31. Effect of complexity

Curves which rise from the time axis at the same point, but which differ in slope, reveal the effect of change in complexity. These five curves are illustrations of the effects of such a change. The words, together with their complexities (Detroit, 1931), for which these are the fitted curves, are: (1) "hot," 7.3; (2) "sugar," 14.5; (3) "clerk," 21.2; (5) "telegram," 34.1; (7) "disappoint," 48.8. The words are, therefore, approximately in the ratio, 1 : 2 : 3 : 5 : 7, with respect to their complexity.

way to a ready and easy computation by which to secure the measure, spelling complexity. Using this system, one may express complexity mathematically as the quotient of 100 divided by r, in which 100 is the number of isochrons in the complete cycle of maturation and r is the yearly increment in isochrons. The

complexity of a word thus derived therefore yields immediately the number of years required for a given word to pass through the complete cycle of maturation.

As has been indicated, the analysis of the constancy of complexity from 1926 to 1931 has been carried out on two bases. First, curves were fitted to "percentages correct" in successive

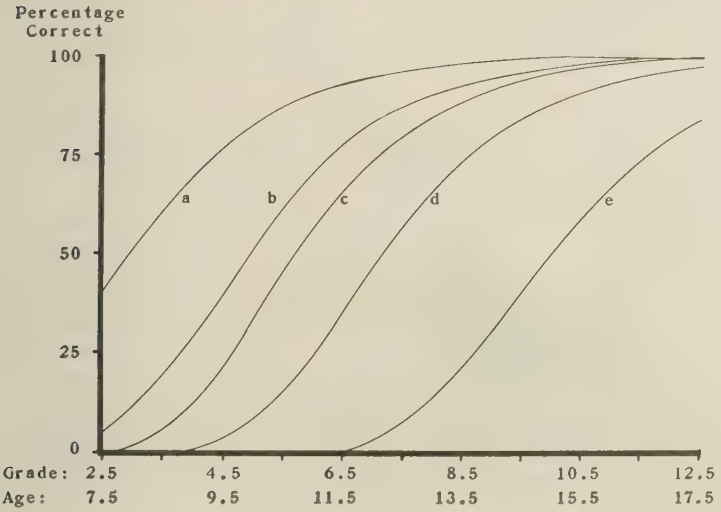

FIG. 32. Effect of displacement in time

Curves that are of the same slope, but differ in the point at which they rise from the time axis, must not be confused with curves that differ in complexity; they represent differences only in time-placement. These five curves represent words of very nearly equal complexity although they differ greatly in time-placement. The words, together with their complexities (Detroit, 1931), for which these are the fitted curves, are: (*a*) "down," 18.0; (*b*) "visit," 18.1; (*c*) "human," 18.2; (*d*) "successful," 18.3; and (*e*) "pneumonia," 21.1.

groups where the pupils selected were in-grade-at-age. Second, the curves were based upon the percentage of pupils in successive total-age groups spelling the word correctly. The results from each of these analyses will be presented in turn.

Little conception of the wealth of detail which these analyses

revealed can be obtained without an opportunity to review the curves for all the fifty words of the two surveys. Some idea of the striking regularity of pattern in 1926 and 1931, of the problems involved in measuring complexity of words which are in the course of study and of words which are not, and of the typical

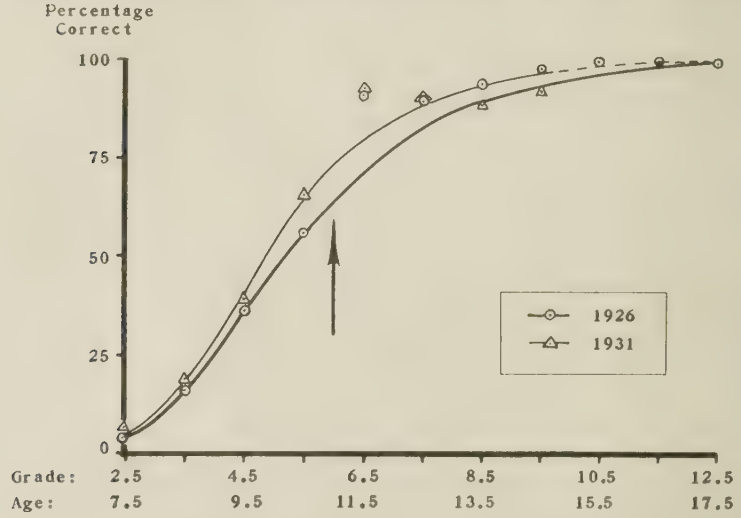

FIG. 33. Measurement of complexity of word in which development reflects the effects of teaching

Percentage of pupils in-grade-at-age who spelled the word "visit" correctly in Detroit surveys of 1926 and 1931

The development of the word "visit" reveals the irregularities which are typical of the curves for words in the course of study. The departure from the smooth curve which occurs above Grade 5.5 (end of 5B) is apparently associated with the effects of teaching, for the word "visit" is found in the Detroit course of study for Grade 5A. So far as possible in cases of this type, complexity has been measured in terms of the curve established by development *before* formal teaching occurs. The complexity of "visit," measured on in-grade-at-age groups, is found to be 20.0 for 1926, 18.1 for 1931. This measure, it should be noted, reports but one aspect of the consistent pattern which the results of the two surveys reveal.

change in complexity discovered through this analysis may, however, be gained from a few sample words. Three must suffice.

The word "visit" (Fig. 33) is taught in Grade 5A according to the Detroit course of study. Nevertheless, more than fifty

per cent of pupils in-grade-at-age can spell it successfully before they reach the fifth grade. The complexity of "visit" in 1931 was apparently less than it was in 1926.

"Recommendation" (Fig. 34) is a more difficult word than "visit." Although "recommendation" does not appear in the

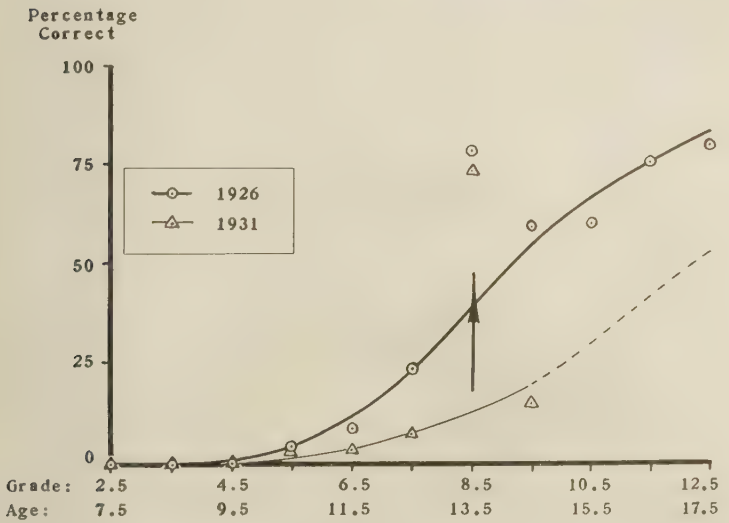

FIG. 34. Measurement of complexity of word in which development reflects transfer of training

Percentage of pupils in-grade-at-age who spelled the word "recommendation" correctly in Detroit surveys of 1926 and 1931

According to the Detroit course of study in spelling, the word "recommendation" is not taught, as such, in any grade. The word "recommend," however, is taught in Grade 8B. The distinct break at Grade 8B in the curve of the derivative apparently is related to the effects of training upon the root word. In cases of this type, complexity has been measured in terms of the curve established by development before the appearance of such effects. The complexity of "recommendation," measured on in-grade-at-age groups, is found to be 28.2 for 1926, 41.8 for 1931. This measure, as in the case of "visit," reports but one aspect of the consistent pattern of development which the results of the two surveys reveal.

Detroit course of study, the word "recommend" does. Apparently the effect of teaching "recommend" in Grade 8B is reflected in the irregularities of the curve of its derivative, "recommendation." The slope of the curve in 1931 is considerably less

steep than that for 1926. The complexity seems to have increased over the five-year interval.

Between 1926 and 1931 the most typical change which is reflected in measures of complexity is approximately that shown by the word "electrical" (Fig. 35). Its complexity of 21.2 in

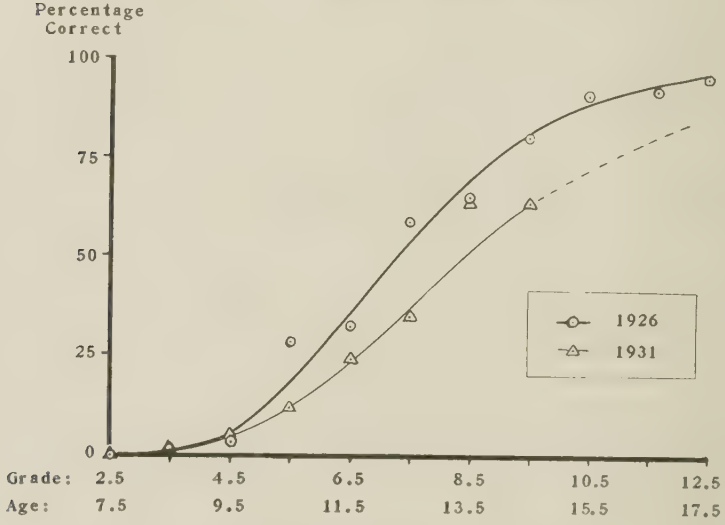

FIG. 35. Measurement of complexity of word which is not in course of study

Percentage of pupils in-grade-at-age who spelled the word "electrical" correctly in Detroit surveys of 1926 and 1931

The curves for the word "electrical" are typical of curves for words which are not in the Detroit course of study. The departures of observations from the fitted curve reflect irregularities which are present in greater or less degree in the results for many words. In such cases the curve is fitted to the entire set of observations, each observation being weighted roughly in terms of its relative reliability. The complexity of "electrical," measured on in-grade-at-age groups, is found to be 21.2 for 1926, 29.6 for 1931.

1926 increased to 29.6 in 1931. Though the list as a whole has in it many words of the types shown by the words "visit" and "recommendation," by far the largest single type is that illustrated by the word "electrical."

The distribution of complexity based on in-grade-at-age groups

(Table III) reveals, as have former measures, a noticeable increase in apparent difficulty over the five-year interval. Whereas the measures of central tendency in 1926 were approximately 21, those of 1931 were approximately 25.5.

But complexity may be based on total-age groups, as well as upon grade groups. An interesting comparison of the change

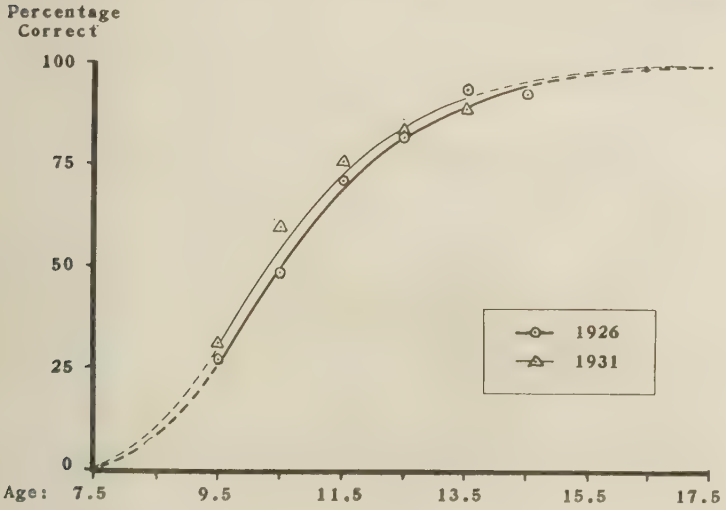

FIG. 36. Complexity of "visit" as measured on total-age groups

Percentage of pupils in total-age groups who spelled the word "visit" correctly in Detroit surveys of 1926 and 1931

The development of the word "visit," when measured on total-age groups, reveals none of the decided irregularities which characterized its development when measured on in-grade-at-age groups. Consequently, the curve is fitted to those observations which are known to be most reliable in terms of the sampling available. The complexity of "visit," measured on total-age groups, is found to be 17.4 for 1926, 16.0 for 1931.

produced by this basis for analysis is shown in the new curves for "visit," "recommendation," and "electrical." The curves for "visit" (Fig. 36) are similar to those found on the in-grade-at-age basis, with the exception that many of the irregularities have disappeared. The complexity, as in the earlier case, has somewhat decreased. The word appears to have been easier in

1931 than it was in 1926. The divergent curves for the two years on the word "recommendation" (Fig. 37) appear on this new analysis to be identical. In this particular instance there is complete constancy in the measure of difficulty. The complexity was 25.8 in both years. "Electrical," which showed differing

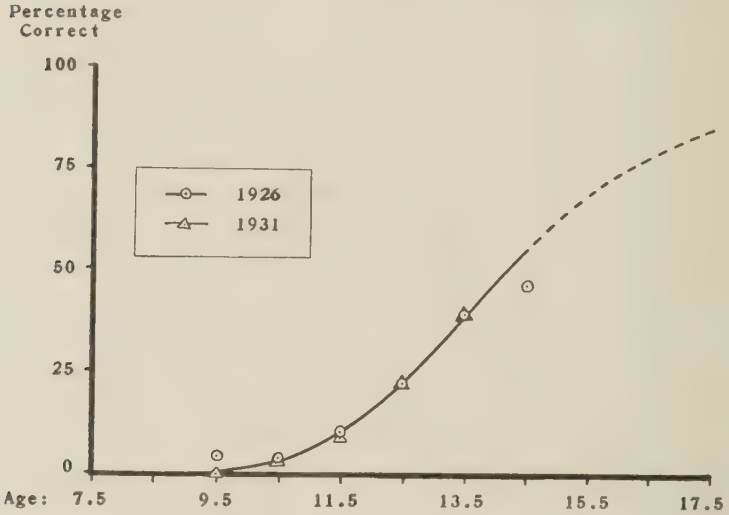

FIG. 37. Complexity of "recommendation" as measured on total-age groups

Percentage of pupils in total-age groups who spelled the word "recommendation" correctly in Detroit surveys of 1926 and 1931

The development of the word "recommendation," when measured on this basis, reveals neither the irregularities which appeared in Grade 8B on the other basis, nor the divergence of the 1931 curve from that of 1926 which appeared in the former analysis. In each year the complexity of "recommendation," as measured on total-age groups, is 25.8.

complexity through its two curves on the former analysis, now appears to have had very nearly the same complexity in the two surveys (Fig. 38). The curves for the two years are practically parallel. In other words, although the curve is somewhat displaced in time, "electrical" was but slightly more complex in 1931 than it was in 1926.

The distribution of complexities on the basis of total-age groups (Table IV) reveals considerably less of an average increase in difficulty over the five-year span than did complexities based upon in-grade-at-age groups.

In summary of the evidence up to this point, it may be noted that the tendency of the findings is the same in every case.

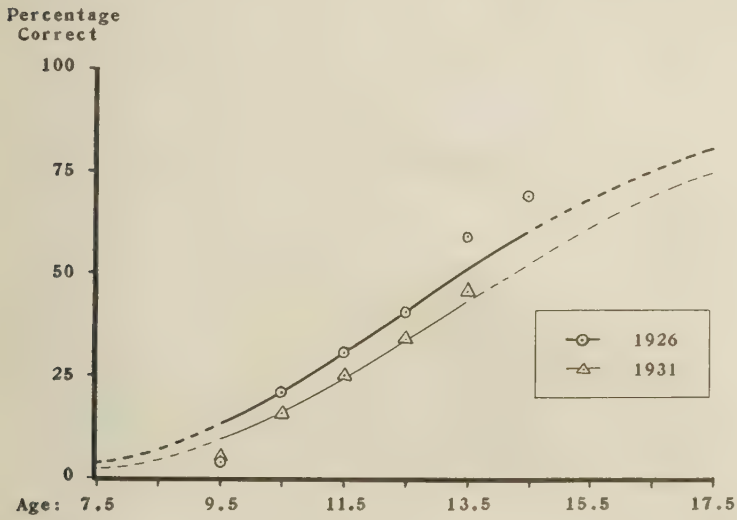

FIG. 38. Complexity of "electrical" as measured on total-age groups

Percentage of pupils in total-age groups who spelled the word "electrical" correctly in Detroit surveys of 1926 and 1931

Whereas the two curves for the development of the word "electrical" diverged at an angle when measurement was based upon pupils in-grade-at-age, the development curves for the same word become practically parallel when based upon pupils in total-age groups. The complexity, measured upon the new basis, is found to be 40.8 for 1926, 41.2 for 1931.

Whether the measure be percentage correct or the sigma position, whether it be spelling complexity based upon in-grade-at-age groups or spelling complexity based upon total-age groups, the findings consistently are that apparent difficulty in 1931 was greater than in 1926.

These general measures, of course, do not reveal in more than

TABLE III

Distribution of Words according to Spelling Complexity, Measured on in-Grade-at-Age Groups

Complexity	1926	1931
65–69	..	1
60–64	..	..
55–59	..	..
50–54	1	2
45–49	1	1
40–44	..	2
35–39	1	..
30–34	7	11
25–29	7	9
20–24	10	4
15–19	7	8
10–14	8	6
5–9	8	6
Total	50	50
Mean	21.2	25.3
Median	21.0	25.6

TABLE IV

Distribution of Words according to Spelling Complexity, Measured on Total-Age Groups

Complexity	1926	1931
75–79	1	1
70–74	..	1
65–69	..	..
60–64	..	1
55–59	..	2
50–54	..	..
45–49	1	3
40–44	2	1
35–39	7	8
30–34	6	5
25–29	8	6
20–24	7	7
15–19	10	4
10–14	5	6
5–9	3	5
Total	50	50
Mean	26.3	29.3
Median	25.0	27.5

a rough way the degree in which the figures of 1926 on the individual words would have predicted the figures for 1931. If the difference between the 1926 measure and the corresponding measure on the same word in 1931 is considered to be the error by which a 1926 value fails to predict that of 1931, and if each such error is related to the 1926 value as a base, it is possible to compare

TABLE V

ACCURACY OF PREDICTION OF 1931 MEASURES OF DIFFICULTY FROM THOSE OF 1926

PERCENTAGE ERROR OF PREDICTION	MEASURE OF DIFFICULTY			
	Percentage correct	Sigma position	Complexity In-grade-at-age	Complexity Total-age
100–up	3	..	1	..
90–99	..	..	..	..
80–89	..	..	..	..
70–79	1	2	1	1
60–69	2	2	1	1
50–59	5	1	3	..
40–49	2	1	9	5
30–39	6	1	7	1
20–29	7	3	11	5
10–19	6	9	7	9
0–9	18	31	10	28
Total	50	50	50	50
Mean	27.5	16.1	30.1	15.9
Median	21.4	8.1	27.3	8.9

the accuracy of prediction of the four measures here reported (Table V). Percentage of correct spelling is found on the average to predict the new value within approximately one fourth of the 1926 value. The 1926 sigma position predicts the new sigma position on the average within about one sixth of its own value. Complexity based upon in-grade-at-age groups appears to give the least reliable prediction; but complexity based upon total-age groups predicts with the greatest reliability of all.

The question must arise whether the apparent increase in difficulty over the five-year interval is truly a change in the intrinsic difficulty of the words or merely a reflection of surrounding conditions which, after all, were not constant. As has been indicated earlier, great care was exercised to secure basic data under similar conditions. Are these evidences of increased difficulty, then, to be attributed to the words themselves?

Search for independent data on changes in surrounding conditions has revealed that in at least two of these measures of difficulty there are embedded the effects of factors which were uncontrolled. For instance, there is considerable evidence that the distribution of ages to be found within grades has changed. A sampling taken from the individual word study itself reflects altered conditions which are known in a general way to exist throughout the city. We find, too, that a tendency to increase rates of promotion, efforts in the direction of keeping children in school longer than formerly, and numerous other administrative adjustments and arrangements have tended to place in upper grades children who previously either remained in lower grades or left school. All these changes may be expected to lower spelling achievement in grades above the third. The net results of such modified conditions naturally reveal increased difficulty in Grade 5B, and consequently greater difficulty in the first two measures analyzed. They also have a general tendency to lower the slope of the curve representing the maturation of ability to spell given words. This would result in an apparent increase in complexity whenever that measure is based on groups whose composition would be affected by such factors. It would, therefore, seem fair to attempt to adjust the 1931 measures of difficulty of the individual words in terms of the average shift of the observed values.

The effect of such adjustment is interesting (Table VI). The accuracy of prediction of the three measures the adjustment of which has been attempted [10] indicates that the accuracy of pre-

[10] In the attempt to adjust percentages of correct spelling certain ambiguities were encountered which prevented the inclusion of their "adjusted" values in this study.

diction for sigma position remains unchanged; that average accuracy of prediction on the basis of in-grade-at-age groups is bettered by one third; but that prediction on the basis of total-age groups is only slightly bettered. In other words, it would appear that in those measures which are least affected by administrative rearrangements, changes in surrounding conditions have little effect.

TABLE VI

ACCURACY OF PREDICTION OF ADJUSTED 1931 MEASURES OF DIFFICULTY FROM OBSERVED MEASURES OF 1926

PERCENTAGE ERROR OF PREDICTION	MEASURE OF DIFFICULTY		
	Sigma position	Complexity In-grade-at-age	Complexity Total-age
100–up	..	1	..
90–99	2	..	..
80–89	2	..	..
70–79	..	..	..
60–69	2	1	..
50–59	1	2	2
40–49	..	2	1
30–39	..	4	3
20–29	2	9	7
10–19	8	14	15
0–9	33	17	22
Total	50	50	50
Mean	16.1	20.7	15.1
Median	7.6	15.7	12.0

It might appear from this evidence that sigma position was as nearly constant a measure for prediction as any other. It should be observed, however, that the sigma used in this study is based upon but a single grade. The number of cases involved in its derivation is relatively small. Further, the grade in which it has been used is the grade in which best results are expected. To measure with this device in almost any other grade yields figures much less favorable to it.

So long as grade is in danger of changing its meaning through changes in administrative policy concerning promotion rates, the retention of pupils in school, and so on, it would appear that in-grade-at-age groups, although they probably are a better basis for prediction than merely total-grade groups, are nevertheless not productive of as constant measures of difficulty as either sigma position or spelling complexity based upon total-age groups.

Spelling complexity based upon total-age groups appears to combine a number of significant advantages. The measure summarizes quickly and significantly the accomplishment of pupils with a wide range of ability. Because this measure is based upon the achievement of so many more cases than were the other measures used here, it may be entitled to somewhat greater consideration than they are. The ultimate test, however, is to be found in its constancy of prediction over a wide range. When it is realized that the device measures complexity in the older ages and in the younger ages with ease nearly equal to that in the middle groups, it will be seen that spelling complexity based on total-age groups deserves further study.

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